SCIENTIFIC AMERICAN
No. SUPPLEMENT 123

Scientific American Supplement, Vol. V, No. 123.
Scientific American, established 1845.

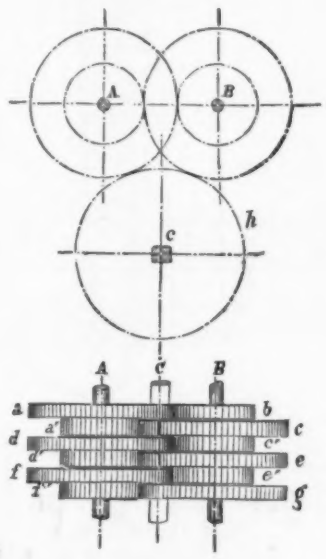
NEW YORK, MAY 11, 1878.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

NEW DOUBLE HAY COMPRESSOR.

At an agricultural show lately held at the Champs Elysées, M. Albaret exhibited a hay compressor, which we describe and illustrate after the *Revue Industrielle*. We may remark that the compressor will serve for wool, hair, cotton, tow, etc., as well as for hay, but its chief uses appear to be indicated by its make for the last-named substance. In the frame, which is built, of course, in a very solid manner, moves a piston head which separates the interior of the press into two parts. A couple of screws, which take power from a peculiar system of toothed wheels, described further on, pass into a couple of strong screw boxes, one on each side of the press, braced to the piston head by iron bars which pass through the chest at openings contrived on purpose. At each extremity of a shaft is placed a fly wheel fitted with a handle, each usually accommodated for being worked by one man. These fly wheels set in motion the gearing already adverted to, which is capable of giving a variable velocity to the piston head, while the work remains constant at the fly wheel, this effect being obtained easily and rapidly by throwing a wheel out of gear, and compression is thus carried out in the smallest possible time.

The combination of toothed wheels adopted is ingenious, and deserves separate mention. The three axes, A, B, C, shown in the drawing, are parallel, A and B being each at an equal distance from C. On the spindle, B in the diagram, is geared a pinion, *b*, which actuates the double wheel, *aa'*, running loose on the spindle, B. The pinion, *c'*, in turn drives the loose double wheel, *dd'*; the pinion, *d'*, drives the double wheel, *ee'*; the pinion, *e'*, the loose double wheel, *ff'*, and last of all, *g* is driven by *f'*. If the ratio of the system of wheels is 1 :2, and the spindle, B, has a velocity of 200, we get the following velocities for the successive toothed wheels: *aa'*, 100 revolutions; *ee'*, 50; *dd'*, 25; *ee'*, 12½; *ff'*, 6¾; *g*, 3½. The wheel, *h*, slides on the square spindle, C, and gears successively with the loose wheels, *a*, *c*, *d*, *e*, *f*, *g*; the velocity communicated to the shaft has a wide range of variation, and the driven power given off varies, of course, with it. Worked by hand with four men, two at the fly wheels, a bale weighing three half-hundredweights is made up in eighteen minutes; driven by horse-power or steam, seven bales of the same weight are made up in an hour. When the hay or other matter is sufficiently compressed, workman No. 3 proceeds to bind, and No. 4 to fill the empty half of the press. The piston is then worked in a direction opposite to that of its last operation by simply reversing the action of the driving wheels. In the case of a truss of hay, the bands are usually eight in number, and consist either of cord, hoop-iron, or wire. When the truss is bound it is mostly forced out of the press from above, but a recent improvement enables it to fall free of the press by its own weight, the truss being liberated by the return of the piston on its journey to the newly filled half of the press, aided by a lever actuated by a chain communicating with the piston head. The frame is made slightly larger below than it is above, to facilitate the dropping of the bale. When the compressor is driven by steam, the apparatus is thrown out of gear by a spring which comes into action as soon as the maximum pressure is obtained, and shifts the driving band to a loose pulley. By means of a lever and coupling apparatus the action of the piston is reversed, and the newly made bale stands to be bound. While this is being done the empty compartment



is filled, and compression, binding, and release go on as before. Filling, indeed, can be begun as soon as the piston head has passed beyond the first trap-door.

The compressor can be made portable or semi-portable, and the necessary details of its manufacture are, we are assured, carried out with the greatest care.—*Iron.*

THE ENGLISH BUILDING TRADE STRIKE.

The great building trade strike which has recently terminated in England is remarkable because it has not been remarkable: a paradoxical expression, it is true, but justified from the fact that it is rarely that an uprising of such magnitude occurs but that it inherently possesses some phenomenal or abnormal features, which beyond all else determine its failure or success. In the present instance there seemed to be reason for the strike, and its maintenance was characterized by a forbearance and respect for the rights of others under circumstances which might well not have been expected. In other words, here was an apparently judiciously begun, well organized, and well supported strike. It has turned out a disastrous failure.

According to inquiries instituted by Mr. Brassey, masons' wages in England have not risen as much as might have been expected from the prosperity of the trade. Neither for the past thirty years has the increase in wages kept pace with the enhancement of cost of necessaries of life. Recent legislative acts gave occasion for brisk business in the building trades, the depreciation of investment securities abroad augmented the value of real estate at home and apparently in the face of a strong demand for their labor, and consequently, it might be argued, with every indication of success the masons struck for shorter hours and more pay.

One result of this was the importation of workmen from the United States, from Canada, Germany and Italy, in all numbering some six hundred. These at first were met with appeals to their class feeling, and the offer of a free passage home; but eventually the strike funds became low, the men fell back upon their own savings, and soon other workmen not connected with the striking unions began to compete. The numbers of these last, as compared with those of the foreign workmen imported, soon showed that the latter were not an important factor in the problem. Finally the men surrendered unconditionally, losing $150,000 in money, and wages for thirty-three weeks.

The mistake seems to have been in the neglect on the part of the men to appreciate that although their cause might have sufficient justice to support it, the time was inopportune. That there was some demand for their work was evident, but that it was sufficient to cause a raise of wages was not so, and this was owing to the general depression in all branches of industry. Every place made vacant by a disaffected workman at such a time another man was anxious for the opportunity to take, the area of competition was widened, and the condition of those who had thrown up their employment rendered worse. The basis of the difficulty was simple ignorance of the true condition and prospects of the trade, a fact which, the *Saturday Review* cogently points out, illustrates the wisdom of Mr. Brassey's recommendation to the trades unions to spend less in contests and more in trying to understand the real state of their business.

NEW DOUBLE HAY COMPRESSOR.

THE VICTORIA DOCK EXTENSION.

For more than two years past some works of considerable magnitude, and of no less importance, have been going quietly on in the neighborhood of Silvertown, and have been, in fact, gradually transforming a vast tract of desolate marsh land into what will be, when completed, one of the finest commercial docks in the United Kingdom, if not in the world. These works are those of the Victoria Dock extension which are now being carried out for the London and St. Katharine Docks Company from the designs of Mr. A. M. Rendel, M.A., M. Inst. C.E., under the superintendence of Mr. A. C. Andros, M. Inst. C. E., by Messrs. Lucas & Aird as contractors, and whose agent on the works is Mr. W. Colson. The extension owes its origin to two circumstances mainly. In the first place, the present entrance to the Victoria Dock at Blackwall has for long past been inadequate to the requirements of the dock, while the accommodation of the dock itself has long proved unequal to the demands made upon it by the ever-increasing exigencies of commerce. The London and St. Katharine Docks Company—to whom the Victoria Dock belongs—had foreseen this probable contingency, and had taken early steps toward meeting it by the purchase of a large tract of land extending from the eastern end of the present dock to Galleons Reach, a stretch of about two miles. By having an entrance to the dock at the latter place, vessels will be enabled to avoid the intricate navigation of 3¼ miles through Woolwich and Bugsby Reaches, that being the distance between the new entrance and the present one to the Victoria Dock at Blackwall, owing to the bend in the river. This saving is a very important commercial consideration, especially when the contiguity of the North Woolwich Branch of the Great Eastern Railway is borne in mind. This saving will be clearly seen from the plan of the docks shown in our engravings.

The works comprise a couple of open timber jetties extending 250 ft. into the river at Galleons Reach, an entrance lock nearly 800 ft. in extreme length by 80 ft. wide, an entrance basin having an area of 10 acres (which alone is equal to the area of the present St. Katharine Docks), and a main basin having 80 acres of water area. Above and beyond this the works include the construction of graving docks and the diversion of the North Woolwich Branch of the Great Eastern Railway from its normal route, and its eventual restoration to the line of that route, but at a maximum depth of 40 ft. below its original level. This involves the construction of a heavy piece of tunneling, so that in point of fact it may be said that the undertaking comprises four distinct works of an unusually heavy character, viz., the entrance lock and basin, the main basin, the graving docks, and the railway tunnel. It is in this light, for the purpose of description, that we propose to view them, and in the above order that we intend to notice them. We are indebted to the courtesy of Mr. Rendel for the drawings from which our engravings are taken. To Mr. Andros especially are our thanks due for his kindness in accompanying us over the ground.

The general arrangement of the works (including the present docks) will be seen from the plan, Fig. 1 of our engravings. Taking first the entrance at Galleons Reach, we may observe that its situation has been admirably chosen, the river being at that point one-third wider than it is at the present entrance at Blackwall. This entrance is 130 ft. wide at the commencement of the masonry, and is flanked on either side by two open-timbered jetties projecting 250 ft. into the river, and gradually curving outward so as to present an opening of 530 ft. at the head of the jetties. A very good example of coffer-dam work is to be seen at the entrance to the docks, having been introduced for the purpose of keeping out the tidal water during the construction of the outer lock gates, which will occupy the site of the old river wall which has been cut through at this point. This wall, so called, is an embankment of clay, which excludes the river from the marsh lands for miles in length, and is supposed to date back to the days of King Alfred. It consists of two rows of sheet piling, composed of 14-in. square timbers, 48 ft. long, with calked joints, the space between the inner and outer rows being filled in with Medway puddle which reaches to the tops of the piles, which are 6 ft. above T.H.W. The dam is supported on the inner or landward side by three rows of raking piles or struts. Outside the coffer-dam runs a platform, while the roadway for the public along the river bank has been diverted at this point, and is carried on piles on the landward side of the dam. The total length of the coffer-dam is 180 ft. As a further precaution a temporary safety-bank has been thrown up across the basin beyond the lock, and which would save the dock works and surrounding country from inundation should any accident happen to the coffer-dam. This, however, is hardly probable now, as the structure has successfully withstood some of the highest tides known.

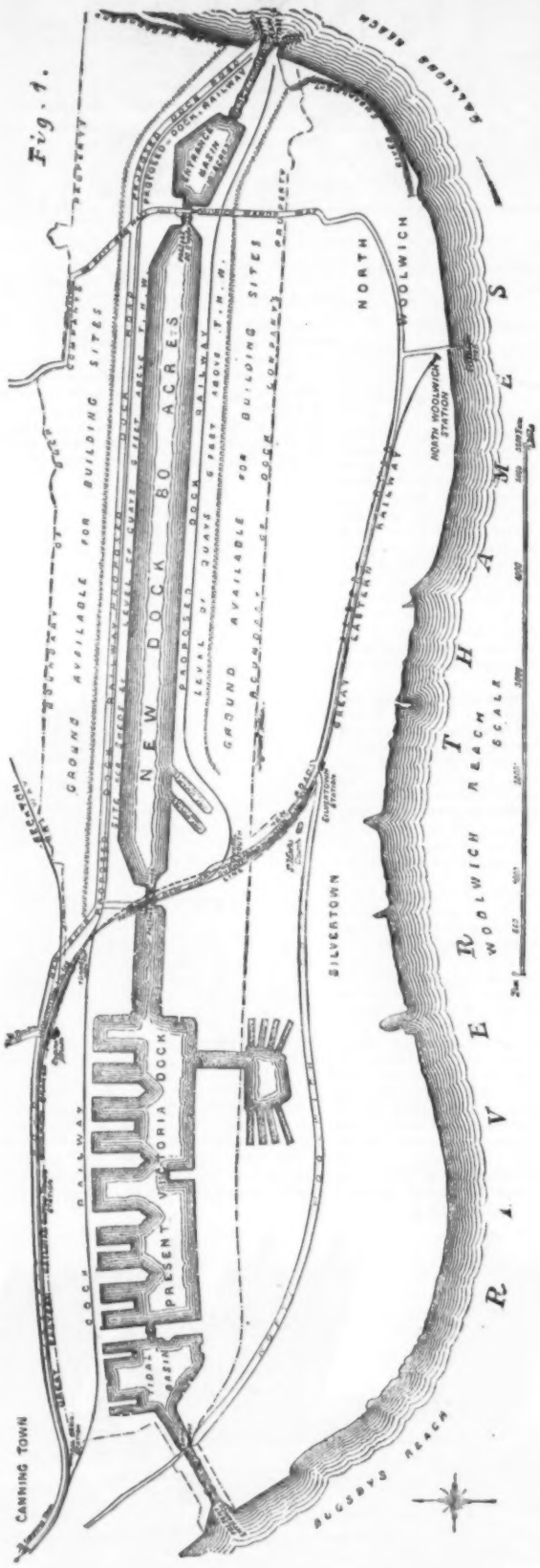
The entrance lock is 550 ft. long between the outer and inner gates and 80 ft. wide, thus offering facilities for vessels of extreme length to enter for docking. There is also an intermediate pair of gates placed 400 ft. from the outer gates. The depth of water on the outer sill will be 30 ft. below Trinity high water. The masonry and arrangements of the lower or entrance gates are shown in plan and section at Figs. 2, 3, and 4 of our engravings, Fig. 2 being a half coping plan and half sectional plan through the culverts and sluicing ports, and Figs. 3 and 4 transverse sections on lines marked on Fig. 2. The walls of the lock have been constructed in concrete, but have a facing of gault bricks 2 ft. 3 ins. thick. This is the only part of the work—with the exception of the invert apron and floor—in which bricks have been used, and the object here is to provide against the wear and tear to which entrance locks are specially subject, and which the concrete face might not so well withstand. The culverts for the passage of water from one side of the lock gates to the other are of more than the usual area, in order to facilitate the passage of vessels into and out of the lock. Near the outlet ports the culverts are provided with two shutters of greenheart timber working in penstocks in Penrhyn granite. These shutters will be worked by hydraulic power, and are in duplicate on each side of the lock as a precaution against accident. The chamber for the hydraulic machinery is seen on the coping plan. The walls of the culverts are 7 ft. in thickness, and are of gault bricks set in cement, and faced with the best Staffordshire blue bricks pointed in cement mortar, made of sand and cement, mixed at two to one.

The masonry of the culverts and of the entrance generally is executed in Penrhyn granite and Bramley Fall stone, while such prominent points as are liable to suffer from friction are all faced with Staffordshire blue bricks. To the front of the lock gates double grooves are provided, as shown in Fig. 2, for constructing a 14-in. pile coffer-dam should such be required at any time during repairs to the gates. There will be a depth of 33 ft. of water over the entrance sill. In view of possible contingencies in the future, in connection with the main drainage of the metropolis, the Metropolitan Board of Works have obliged the dock company to construct two low-level sewers, which are carried across the lock beneath the floor. These sewers are each 4 ft. in diameter, and are built in brickwork in cement. The penstock chambers connected with the sewers are also of brickwork in cement.

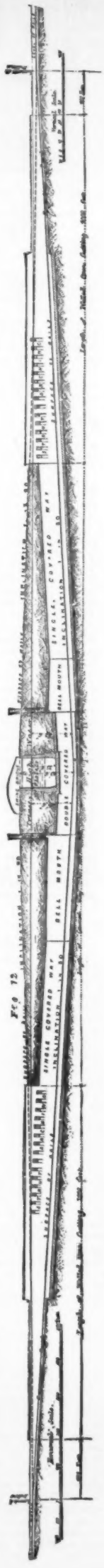
The entrance basin beyond the lock has a water area of ten acres and communicates through a passage 80 ft. wide with the main dock. Across the passage a swing bridge of 80 ft. span will be constructed to carry the Woolwich Manorway across the dock, as shown in the plan. Beyond the swing bridge will be another pair of gates similar in general design to those already described, and opening directly into the main basin. This splendid dock will be 6,500 ft. long by 490 ft. wide, with a water area of 80 acres. It will have a minimum depth of water of 27 ft. below Trinity high water, while the level of the quays will be 6 ft. above that line. The walls of this basin—as well as those of the entrance basin—are being constructed entirely in Portland cement concrete, mixed in the proportions of 7 to 1, and deposited *in situ*. With the single exception of the government works now under construction at Chatham Dockyard, we believe these docks constitute the first example of this method of construction applied to this class of work and on the present enormous scale. Transverse sections of the dock wall are shown at Figs. 5 and 6, Fig. 5 showing the wall between the counterforts and Fig. 6 being a section taken through the bollard counterfort. The walls are 38 ft. 6 ins. high from foundation to coping, and 18 ft. thick at the base, stepped off in the rear to 5 ft. at the coping, as shown. The coping is of concrete in the proportions of 5 to 1. The face of the wall has a batter of 1 in 27. The counterforts are 10 ft. thick, and are placed 50 ft. apart center to center. The bollards are of cast iron and are bolted down in the manner shown at Fig. 6; they are placed 100 ft. apart. From Fig. 5 will be seen the difference between the ordinary level of the marshes in which these docks are being constructed and the level of Trinity high water, the latter being some 7 ft. above the former. The aggregate length of walling will be nearly four miles.

The main basin will be connected with the present Victoria Dock by a cut or passage 200 ft. long and 80 ft. wide. Over this passage the railway

Fig. 1.



THE VICTORIA DOCK EXTENSION WORKS, LONDON.



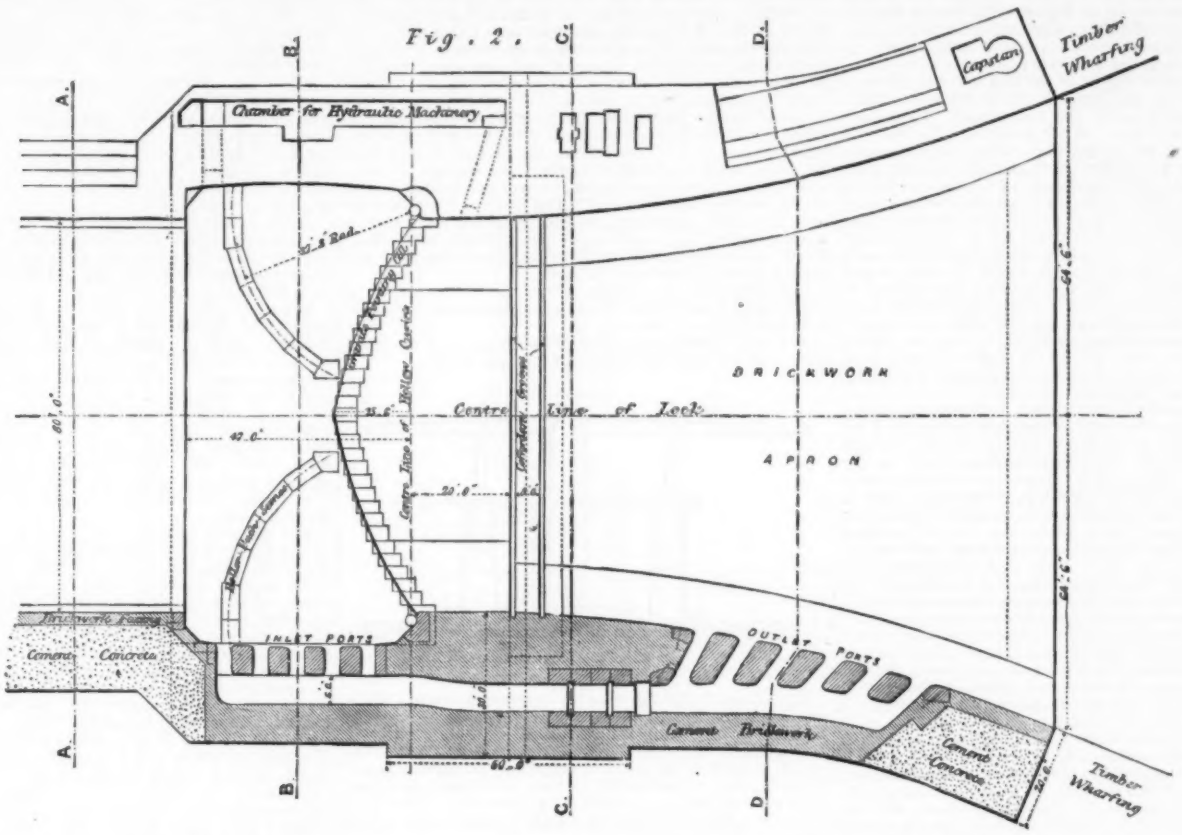
traffic of the docks as well as a public roadway will be carried by a swing bridge of 80 ft. span.

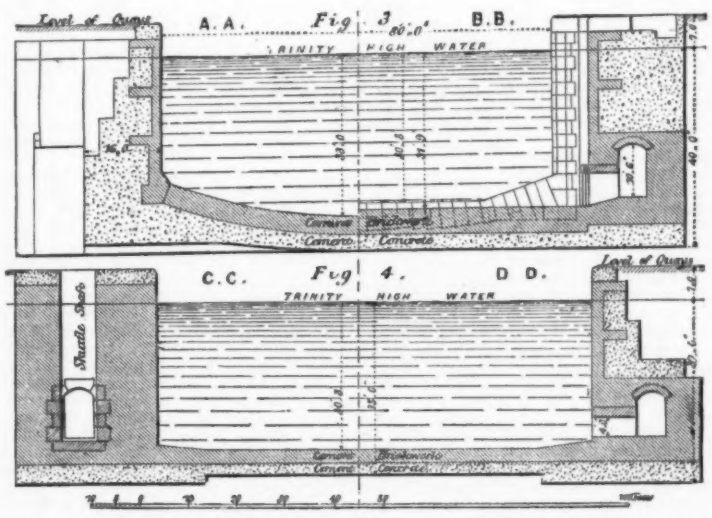
This roadway will be a continuation of the present road which skirts the Victoria Dock, and it will connect the North Woolwich Road with the Albert Road, at Canning Town. The road from Canning Town will further be continued along the northern side of the main basin of the new docks. It will intersect the Woolwich Manorway as diverted, and be carried up to the new entrance, as seen in Fig. 1. A railway will command both north and south quays, and will be connected with the Great Eastern system through the North Woolwich Branch, where it crosses at the junction of the old and new docks, and where the dock railway will be a surface line, passing over the swing bridge, as already explained. Along the quays will be erected the necessary import and export sheds, warehouses and offices, timber depots, coal staiths, sheers, cranes, and other conveniences for vessels resorting to the docks. Beyond all this there is a comprehensive scheme under consideration for laying out the ground belonging to the company outside that required for the purposes of the dock traffic, for the erection of roads, dwellings, public buildings, hotels, manufactories, cattle depots, in fact a small town.

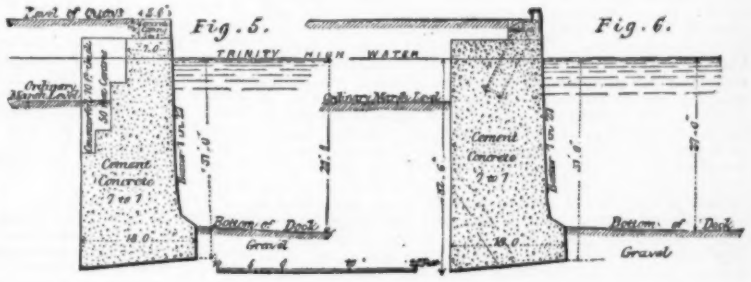
There will be two graving docks, and they will be situated on the south side of the main basin at its western end, and will be made at a diagonal line with the face work, in order that the docking or undocking of ships shall cause as little interference as possible with vessels in the basin. The docks as at present designed will be constructed of Portland cement concrete, which at the sill and the grooves for the caissons will be faced with brickwork and granite. The larger dock of the two will be 500 ft. long on the floor, 84 ft. wide at coping, and will have an entrance 68 ft. wide. It will be capable of docking the largest ironclad at present afloat. The smaller dock will be 410 ft. long on the floor, 76 ft. wide between the copings, and will have a width of 60 ft. at the entrance. Both docks will have a depth of water on the sills of 21 ft. below Trinity high water, and their entrances will be closed by wrought-iron caissons.

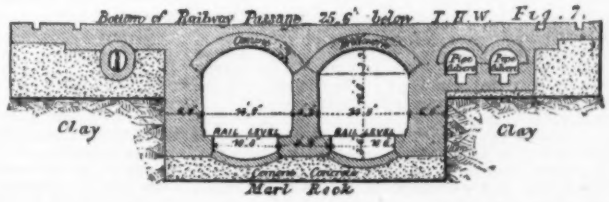
The works connected with the diversion of the North Woolwich Branch of the Great Eastern Railway from its original route and level next present themselves for description. We may premise that this line formerly traversed the ground near the junction of the main basin with the old docks. It was first temporarily diverted considerably eastward to its present line of route, and at the same ground level, pending the construction of the subway through which it will eventually pass. When this work is finished the railway traffic will be restored to its former line of route, but not to its original level, as the trains will run at a maximum depth of 40 ft. below that level, or 43 ft. 6 ins. below Trinity high water. The tunnel is a fine piece of engineering work, 1,800 ft. long, exclusive of the approaches. The rails will be laid at an incline of 1 in 50 from either end, the inclines meeting in the center of the tunnel, which will there pass under the passage or waterway connecting the main basin with the old dock. At that point there will be 25 ft. 6 ins. of water over the tunnel when the docks are completed. Figs. 7 to 11 of our engravings show sections taken at several points of the work, both in the covered way and in the open cutting, while Fig. 12 shows a longitudinal section of the whole work. It will be seen that that portion of the tunnel which carries the railway under the water passage is double, one side

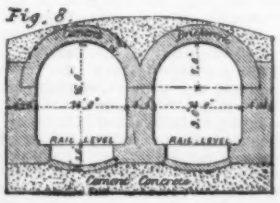
Fig. 2.

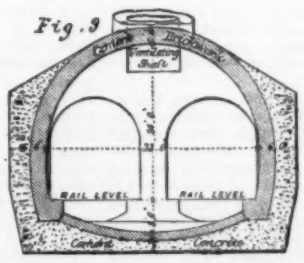


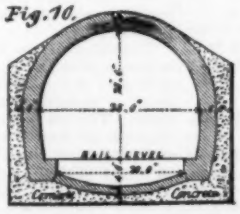


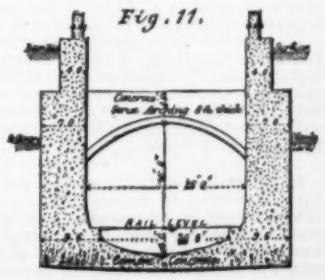












THE VICTORIA DOCK EXTENSION WORKS, LONDON.

being for the up and the other for the down trains. The object of this double construction is to diminish the height of the work at that point, so as to obtain a sufficient depth of water overhead without having to carry the line at a lower level. The whole of the construction here, as seen at Fig. 7, is brickwork in cement, with the exception of a bed of cement concrete, 4 ft. thick, laid upon the marl rock, which forms the foundations. Beyond the passage the double way is also constructed in brickwork, but the arches are covered in with cement concrete, as shown at Fig. 8. The double tunnels extend for a length of 350 ft., each being 14 ft. wide and 16 ft. high from rail level to crown, except immediately under the passage, where the height is reduced to 13 ft. 9 ins. The double way opens out at either end into a single-span bell-mouth or tunnel, additional headway being attainable here as the works pass under the marsh land. These bell-mouths are shown at Fig. 9. They are 24 ft. high from rail level to underside of crown and 33 ft. wide. At the points where the double way merges into the single, ventilating shafts are provided. Like the double way, the single tunnel is constructed of gault bricks in Portland cement, and is backed by and bedded on Portland cement concrete. The whole of the tunnel is further protected by 18 ins. of clay puddle on the outside. The bell-mouth merges at both ends into an ordinary tunnel 20 ft. high and 25 ft. wide, of the section shown at Fig. 10. In open cutting the railway is carried between concrete walls 7 ft. thick, and strutted at intervals of 16 ft. with concrete arches 8 ft. thick, as shown at Fig. 11. The tunnel is drained through a culvert, which conducts the water from the lowest level to a well, from whence it will be pumped by hydraulic engines, worked by an accumulator fixed inside the well itself.

Such is the comprehensive scheme of dock accommodation which at no distant period will be available for vessels of the largest type, not only in our mercantile marine, but, if needs be, of the Royal Navy. The contract was signed on the 9th of November, 1875, and it is expected that the works will be completed within the contract time, which will be March, 1879. The cost of the works already contracted for exceeds £650,000, but this is exclusive of dock gates, caissons, swing bridges, hydraulic machinery, roads, railways, warehouses, sheds, fencing, and the like. Some idea of the extent of the undertaking may be gathered from the fact that before the works can be completed more than 3,000,000 cubic yards will have to be excavated and lifted to an average height of 17 ft. About 75 per cent. of these excavations has already been effected, this work having been greatly aided by three Dunbar's steam navvies, which are made by Messrs. Ruston & Proctor, of Lincoln. Each of these effective labor-saving machines will move ¾ ton of soil at each lift, and will excavate from 450 to 500 cubic yards per day.

The works will absorb 75,000 tons of Portland cement, 700 tons being at present landed and used on the works weekly. Up to the present time 140,000 cubic yards of concrete have been got in, while 30,000 yards of brickwork have been completed. Of the cement the Burham Company are supplying 45,000 tons, while the remaining 30,000 tons are being supplied by Messrs. Gibbs & Co., Messrs. Robins & Co., and the Tunnel Cement Company. The gault bricks are supplied by the Aylesford Pottery Company, and of these 18,000,000 are required for the tunnels, the facings of the dock walls, the culverts, and the like.

The total area of the land owned by the company is 400 acres, and this plot is intersected in all directions by nearly 20 miles of contractors' railways. There are 15 locomotives for hauling some 600 earth wagons. Besides these, about 50 horses are employed on the works, which afford employment to some 1,800 men. There are altogether on different parts of the works 69 fixed and portable steam engines used for various purposes. This is inclusive of three of Messrs. Clayton & Shuttleworth's 40-horse power expansive engines, each of which is working a pair of 24-in. barrel pumps for draining the excavations by Messrs. Simpson & Co., of Pimlico. Each pump has a lift of 56 ft., and is capable of raising 2,000 gallons of water per minute, or 25,000 tons per 24 hours. These engines and pumps are all set on concrete foundations and work very smoothly. There are likewise four 18-in. pumps, each worked by 16-horse power engines, with an average lift of 38 ft. The concrete is made from a valuable bed of gravel which underlies the peat at various levels throughout the estate. It is mixed principally by hand, but also in troughs, in which nine screw-mixers revolve. The gravel and cement, together with the water, are supplied at one end of the trough and thoroughly mixed as they are traversed along by the screw blades, coming out concrete at the other end. Another form of mixer also used consists of a large iron cylinder carried in bearings at opposite points in the periphery at each end. Into this the materials are thrown and made into concrete by twenty-five revolutions of the cylinder.

The hydraulic machinery—the contract for which is of no ordinary magnitude—will be supplied by Sir William Armstrong & Co., of Newcastle-on-Tyne. The contracts for the swing bridges, dock gates, and caissons are not yet let.

Occasional visits to these works enable us to bear willing testimony to the energy with which they are being pushed on, the careful way in which they are being superintended, and the excellent manner in which they are being carried out. Both design and execution in this comprehensive scheme are alike meritorious, and reflect every credit on those engaged in its practical development.—*Engineering.*

A DIVING APPARATUS IMPROVISED IN THE WILDERNESS.

A CORRESPONDENT of the *Railroad Gazette* writes as follows:

The lesson taught by the inclosed story to young engineers is so much needed, that I urged the narrator, father of the hero of the action, to write it down, to be sent to you.

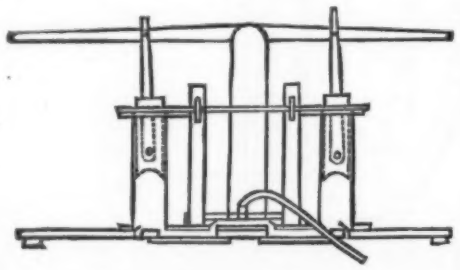
We have become accustomed to *ordering* everything from a manufactory, so that it is refreshing to hear of a return to nature, and to the use of the resources by which an engineer is everywhere surrounded (provided he is himself furnished with the energy and courage necessary to avail himself of them), and this remarkable instance deserves to be permanently recorded.

In the summer of 1876 a steamer was sunk in the Magdalena River, in New Granada, at a point about 300 miles above the port of Barranquilla, near its mouth. The boat was bound up the river, and, as usual with upward-bound boats, was loaded with a rich cargo of dry goods, groceries, wines, liquors, etc., destined for Bogota, the rich capital in the interior of the country. A young man from Salem, Massachusetts, then in Barranquilla, made a proposition to the owners of the boat to endeavor to secure the cargo, and finally made a contract with them to undertake it on shares. His name is Henry R. Cleveland. He is a thoroughly educated machinist, possessed of rare natural ingenuity, and blessed with great physical strength and endurance. He took with him one intelligent assistant, relying on the natives for labor.

On reaching the site, and establishing his camp in the woods, he found that the problem to be solved was, first, to cut through the deck of the steamboat, under four feet of water and two feet of sand, and then to get the cargo out of the hold. He had tried in vain to find a diving apparatus before leaving Barranquilla, and very soon found that nothing could be done without it. He knew nothing by experience of the construction or use of such apparatus, and had no other materials for making it than what he could procure from the wreck and in the woods. Yet with these appliances he constructed a diving suit and pumps for supplying air, by means of which he could remain under water for hours together; and in one month from the time of leaving Barranquilla he returned to that port with an amount of cargo which sold at auction for $6,000, though much of it was, of course, more or less damaged. The people of the country were not a little astonished, and declared that no one but a Yankee or the devil could have accomplished such a feat. His diving apparatus was exhibited at the auction sale, and excited great curiosity and interest.

The head-piece, or helmet, was made of two pieces of plank, resting on the shoulders, and rising above the head, with stiff leather nailed over all.

A canvas jacket was nailed to the bottom of the head-piece, and wrapped and fastened round the body.



The annexed drawing, roughly sketched without a scale, represents the pumps, the action of which can be readily seen and understood by a little study.

The pumps themselves were made of bamboo, cut in the woods, about four inches in diameter, and bound with tarred twine for their whole length. These were fitted into a platform built of planks procured from the wreck. They were set through the upper plank, and melted pitch poured around them.

Another plank was fitted to their tops in a similar way, and keyed down so as to hold them firmly in their places. The pistons were made of smaller pieces of bamboo, fitted with piston heads made of gutta percha, which he found on the wreck, and a brake made of an oar was pivoted, as shown, on a stanchion between the pumps to work them alternately.

It will be seen that passages for air were left between the planks. The air entered each pump through a valve made of a boot leg, and was then forced through the passage and a second valve into the air-chamber, from which an India-rubber hose led to the head-piece of the diving suit. With a man at each end of the brake, this machine proved capable of furnishing a full supply of air, though at first the attendants were greatly alarmed at his long absence under water, and were almost frantic with delight when he reappeared without any signs of exhaustion. The head-piece had no provision for admitting light, neither would it have been of any avail, as the water was so muddy as to be impervious to light.

To most men the thought of groping through the hold of a steamboat under such circumstances, and getting out bales and boxes, would have been somewhat appalling, but he seems to have had no apprehension except of the possibility that his wooden machinery might give out. On this account he was always very careful to keep in his mind the exact bearings of the hatchway through which he must return, and never to go beyond a point from which he felt confident of his ability to get back before drowning, in case of accident to the pumps.

INDICATOR CARDS TAKEN AT THE ST. LOUIS WATER WORKS.

A Paper read before the Engineers' Club of St. Louis, Mo., by A. J. CHAPHE.

KNOWING the interest taken in the subject of indicator cards by several of the members of the Engineers' Club, and having a number of diagrams taken from the engines and pumps of the St. Louis Water Works, and believing some of them contain a lesson that would be interesting, induce me to present your association with a set of indicator cards showing some of the changes and improvements that have been made since first in operation, and illustrating the present condition of the pumping machines. The diagrams are accompanied by a short description of the engines and pumps, their principal dimensions, characteristics and uses, together with a few remarks on the mode of taking indicator cards, their truth and error.

The water for the supply of the city of St. Louis is taken from the Mississippi River at Bissell's Point, and is pumped twice—first, the muddy water from the river into the settling basins near the river bank; second, from the settling basins into the stand pipe, about one mile distant. The city is supplied direct from the stand pipe, the surplus water going into a storage reservoir, situated about four miles from the stand pipe.

The pumping works are arranged in two groups, known as low service and high service; the low service engine house is located on the bank of the river, the high service engine house is situated about one-quarter of a mile west of the river. The low service pumps take the water from the river through 200 feet of 66-inch cast-iron pipe and raise it to the settling basins, the lift varying from 15 to 50 feet, according to the height of the river. From the settling basins the water flows to the high service engine house from whence it is raised about 200 feet into the stand pipe. The low service pumps always have muddy water to raise, the high service comparatively clear water.

These works were put into operation in the spring of 1871, with two engines, Nos. 1 and 2, at each house, one engine at each house as reserve; at this time there were six boilers at the low service and twelve at the high service. In 1874 and 1875 there was an additional engine, No. 3, placed in each house; at this time there were two additional boilers furnished at the low service and four at the high service, of the same size and form as those already in use.

The engines Nos. 1 and 2 at the low service house are "Bull" Cornish, built by the Knapp Fort Pitt Foundry Co., Pittsburgh, Pa., 1870. The steam cylinders and pump plungers have the same diameters, viz., 56 inches; length of stroke, 12 feet; the cylinders are steam jacketed; single acting plunger air pump, 28 inches diameter, 6 feet stroke. Each pump is provided with a stand pipe, which is located in the engine room. Capacity of each pump 17,000,000 U. S. gallons in twenty-four hours. The valves and seats for these pumps are of composition, Government standard, viz., 85 per cent. copper, 10 per cent. tin, and 5 per cent. spellow. They are double beat balanced Cornish, diameter of lower seat 17 inches, diameter of upper seat 15 inches, weight of valve 105 lbs., lift of valve 1¼ inch; they are arranged in two tiers of twelve valves each tier.

Steam for the low service engines is furnished from double flue Cornish boilers, 7 feet diameter and 30 feet long; two flues 30 inches diameter each, grate surface 27½ square feet, heating surface 650 square feet. Two boilers are used with each engine.

Engine No. 3 at either house is of a different type, and larger than Nos. 1 and 2, the object being to utilize the buildings with machinery of larger pumping capacity to meet the rapid growth of the city. At the low service No. 3 is a crank and fly wheel engine with Wright's valve gear and cut-off, built by G. B. Allen & Co., St. Louis, 1874. It works two single acting plunger pumps, one at each end of beam placed in pump pit. Steam cylinder 60″ × 84″ (is not steam jacketed), pumps 50″ × 84″, air pump (single acting bucket) 26″ × 84″. The valves for main pump of No. 3 are of leather, hinged, placed in central chamber in two tiers. The pumps were designed to deliver a million gallons of water per hour.

The pumping engines, Nos. 1 and 2, at the high service, were built by the Knapp Fort Pitt Foundry Co., Pittsburgh, Pa., 1870. They are single cylinder, crank and fly wheel, beam engines working double acting pumps; diameter of steam cylinder 85 inches, length of stroke 10 feet, diameter of fly wheel 26 feet, weight 30 tons. Double acting bucket air pump, worked from beam, 36″ × 60″. The main pump, placed directly under and on the same vertical axis with the steam cylinder, is a Thames Ditton or bucket and plunger pump combined, plunger one-half the area of the bucket, single acting on the suction and double acting on the discharge. Diameter of plunger 36½ inches, diameter of working barrel 51½ inches, stroke same as the steam piston, 10 feet. The pumps receive water through a 50-inch pipe and discharge through a 36-inch rising main. Air chambers of ample capacity are located near the pumps. The valves for these pumps are of the same general form and principle as those of Nos. 1 and 2 low service, but are less diameter and stronger built for their heavier load. Each pump is provided with eleven suction and ten discharge valves. Diameter of lower seat 16 inches, diameter of upper seat 13¾ inches, weight of valve 115 pounds, lift of valve 1⅛ inch. The bucket valve is constructed of the same material and in accordance with the same principle as the smaller valves. Diameter of lower seat 40½ inches, diameter of upper seat 34½ inches, weight 700 pounds, lift of valve 4 inches. Capacity of pumps 16,500,000 gallons each in 24 hours. The steam cylinders have balanced "puppet" valves, worked by toes and lifters from eccentrics on crank shaft. They are provided with Sickels cut-off worked from the beam. The cylinders are steam jacketed and covered with hair, incased in walnut lagging; the steam pipes and tops of boilers are covered with hair felt.

Each engine is usually furnished with steam from six "return drop flue" boilers, 6 feet diameter and 24 feet long, grate surface 25 square feet, heating surface 500 square feet. The products from combustion pass off through four 12-inch flues and return through two 18-inch flues, then passing under the lower half shell of boiler to the smoke flue near the back end.

No. 3 at the high service is a pair of compound engines, connected with crank and fly wheel; built by the Hartford Foundry and Machine Co., Hartford, Conn., 1874. The high and low pressure cylinders are attached to the same beam and have different strokes. The main pumps are the bucket and plunger combined; they are placed in wet well under crank end of beam, with less stroke than the cranks, instead of being set in dry well under the steam cylinder, like those of Nos. 1 and 2. Fly wheel 32 feet diameter and weight 35 tons. The high pressure steam cylinder 50″ × 87″. The low pressure ditto 80″ × 138¼″. The cylinders are not steam jacketed, but covered with hair and incased in walnut lagging, same as are the steam jackets of Nos. 1 and 2 engines. The valves are balanced "puppets" worked by revolving cams driven by gearing from the crank shaft. The air pump double acting bucket 23″ × 54″. The main pump, diameter of plunger 32 inches, diameter of working barrel 45¼ inches, length of stroke 100 inches. The pump valves are of the same material and principle as those of Nos. 1 and 2 pumps. This pair of engines were designed to pump one million gallons of water per hour.

MODE OF TAKING THE CARDS.

On the beam engines motion for the indicator was derived from the parallel motion by attaching to the radius rod at the right distance from the stationary pin to give between 4 and 5 inches movement to drum of indicator. For this purpose No. 22 brass wire was used, cord being entirely unsuitable when length is required as with these large engines, the stretching of the cord seriously interfering with the accuracy of the card. With an elastic cord the cards usually show better than is due to the machines. Should the engine be slow in opening its valves, the fault may not be shown on a card taken with a cord, the drum of the indicator not commencing its rotation until after the piston of the engine and the piston of the indicator have started. This is a very common error. The wire from the radius rod was guided over pulleys 1½ inch diameter to the indicator; larger pulleys would be better for this purpose; the small ones furnished with indicator are not suitable, causing the wire to bend so short it soon breaks. Short pieces of hard cord to bend around the pulleys may be inserted in the wire. Especial care should be taken that the first pulley be located in direct line with the line of the movement, the other pulleys placed wherever convenient.

Suspend about one pound weight to the lower end of the wire below the indicator to keep it straight and on the pulleys, and let it remain while taking cards, whether the cord from drum of indicator is attached or not. Fasten a ring one inch or more in diameter to the wire a few inches above the

indicator for convenience of booking the cord from the drum into. Having adjusted the drum centrally so as not to bring up on either end of stroke, place the paper on drum and trace the atmospheric line, then turn on the pressure, whether steam or water, and let the pencil trace several strokes, noting whether it moves in the same general course, free from undue friction; if it does, proceed to take diagrams; if not, take the indicator apart, clean and oil it; with steam, making a number of strokes also serves to heat up the pipes and indicator. The friction of the indicator should ever be kept in mind while taking cards, indeed the whole use of the indicator is one peculiarly requiring "the mind on the work," for the operator to succeed in attaining true cards.

THE POINT OF ATTACHMENT.

It is generally considered objectionable to attach the indicator to the nozzle of steam cylinders, but in machines with large nozzles, and working at moderate speed, there can be no practical difference between cards thus taken and those taken from the cylinder heads. It is usually more convenient and cheaper to attach to the nozzle than any other point. With small horizontal engines or pumps it is preferable to make attachments near upper part of head; the head can be drilled and tapped without removal, if care be taken to have a steam pressure inside to blow the chips out when the point of the drill is breaking through. As affording ready means for taking double cards, or cards from both ends of cylinder or both chambers of pump, upon one paper, one pipe attached to both ends of cylinder, or to both chambers of pump, with a three ways cock placed centrally in it, with a socket to receive the indicator, can be used.

Care should be taken, in preparing the pipes for indicators, that they contain no dirt, and, in connecting them, that no putty or other material used in making joints be applied to the internal threads, a small quantity only being used on the external, that no foreign substance be admitted to inside of pipe to pass into the indicator.

The same rule should be observed in preparing and connecting pipes for all gauges.

In applying the indicator to a steam engine or pump, one of the most important considerations is that the motion should be as nearly coincident with that of the piston as practicable, also that no lost motion exists in the movement or in any part of the indicator.

When springs of different lengths are used in an indicator the pencil may stand too high on the drum from the spring being too short; to obviate this difficulty place a ring of requisite thickness over the piston rod before putting on the spring. For this purpose it is convenient to have about four brass rings, varying by sixteenths, from one-sixteenth upward; with them the pencil can be adjusted as required; this also allows high pressure cards to be taken with a low pressure indicator when the high pressure or dropped arm cannot be procured. This only brings the atmospheric line nearer the lower edge of the card, without affecting the accuracy of the indicator.

The cards from the several machines are arranged under letters and numbers as follows: Cards from No. 1 high service engine and pump will be known as A cards, and numbered from one upward. Those from No. 2 high service as B, and from No. 3 high service as C cards.

A 1 is from the steam cylinder. Steam is admitted in good time, follows with full pressure one-sixth stroke, is cut off square, and expands in a fair expansion curve; the exhaust valve opens the communication with the condenser, when the vacuum line is produced, coming down early in the stroke and maintaining it to the end.

A 2 is from the air pump. This pump is of ample size for its work, being one-eleventh the capacity of the steam cylinder; is well arranged for dividing the water between the upper and lower channel ways; the lower (shown by right hand end of card) discharges through a rubber valve, the upper end through a floating cover of cast iron, which gives greater resistance, as shown on the card.

A 3 is from the main pump, taken from the lower chamber; shows the suction and discharge, a remarkably regular and even water card, considering the high velocity and pressure with which the pump was working—piston speed 230 feet per minute, against about 100 pounds per square inch in the pump.

B 1 is from the steam cylinder. This card was taken as the valves were originally set, showing the exhaust was too slow in opening, the engine not getting the full benefit of the vacuum until it had made one-quarter stroke; as the power is measured by the area between the steam and vacuum lines, the earlier in the stroke the vacuum is attained the greater the power with the same expense of steam. B 1 was improved by raising the exhaust toes on the rock shaft, causing the valve to open quicker, giving the engine the full benefit of the vacuum earlier in the stroke, as is shown by B 2, which is as the valves are set at present; a like change was made in each engine with like result.

Engine No. 2 has the same stroke as No. 1, but ¾ inch greater diameter of steam cylinder.

The horse power developed by these engines is 750 each, this being their regular work.

B 3 is from the main pump. These pumps, Nos. 1 and 2, work quietly and deliver nearly their full capacity of water, not requiring air to be forced in to make them work smooth.

C 1 is from the right hand high pressure steam cylinder. C 2 is from the left hand ditto, as originally constructed.

The cards show the shortest point of cut-off that could be attained with the engine, at the time being ¾-stroke; at this point it was necessary to throttle the steam. By trial, the shortest point of cut-off to do the work with throttle valve wide open was ascertained, and the brass plates on opening fall of the cams were then reduced from 12½ inches, their former length, to 4 inches, which caused the steam to be cut off the point shown in C 3 and C 4. The furthest that the steam can now follow is 9-16 of the stroke. This with the heaviest work (two engines running and the storage reservoir full) requires the throttle wide open; as the work decreases the cut-off can be shortened instead of throttling.

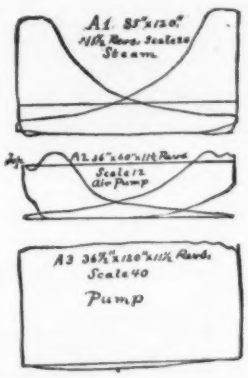
C 3 is from the right high pressure cylinder in its present condition, and C 4 is from the left ditto.

C 5 is from the right low pressure steam cylinder, and C 6 is from the left ditto.

C 7 is from the same cylinder as C 5. This card was taken when the engine room was at a temperature of 60° Fahr. It appears to indicate, as do many others taken from this machine, that the engines would have given better results had they been provided with steam jackets, also were they furnished with a higher pressure of steam.

C 8 is from the air pump. The card shows that the pump was used for nearly half its stroke in discharging water; this gave the best results attainable with them; if more water was used it served to choke the pump the more without producing a better vacuum; this arises from lack of capacity, the pump having less than 1-30 that of the low pressure steam cylinder. In summer they require the injection water to be taken from the force main, not maintaining a vacuum sufficient to allow it being taken from the well. To remedy this defect it is proposed to replace the present pumps with those of greater capacity, using the present channel ways and condensers.

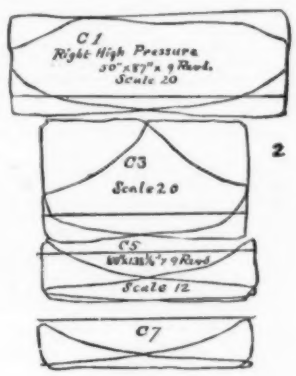
C 9 is from the right hand main pump, and C 10 is from the left hand ditto. These cards C 9 and 10 are presented for the consideration of those who have believed that a smooth water card could not be taken from a crank and fly wheel engine, using steam expansively. Those that have labored to show the unequal pressure and the impracticability of moving water with it steadily may find a lesson here.



The cards from the pumping machines at the low service house will be designated by letters as follows: No. 1 low service by the letter D, No. 2 by E, and No. 3 by the letter F.

The Cornish engines being but seldom used in this country (most engineers having but slight acquaintance with them compared with rotation engines) may excuse a description a little more in detail than given of the other machines.

The steam for these engines is brought through about 200 feet of pipe, the boiler house having been placed some distance from the river bank to secure a firmer foundation. This accounts in part for the appearance of a throttled card. At one half stroke the steam is cut off and expands to the end. At this point the exhaust valve closes and the third valve of the Cornish engine opens. This valve is the equilibrium, serving at the end of the working stroke to equalize the pressure on both sides of the piston; this done,

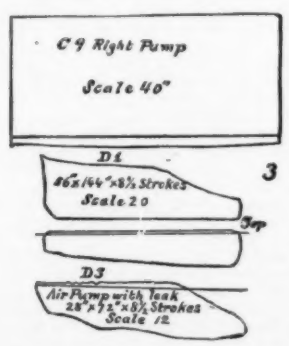


the pump plunger begins descending, moving the water by its weight. The descent is regulated by a throttle valve connected with the equilibrium, called the equilibrium governor valve.

The lines on the card are produced as follows: the outside ones on the up stroke, the steam below and the vacuum above the piston, the inside ones on the return or down stroke.

Was the piston not moving the pressure would be equal on both sides, but as with a high-pressure engine moving at any considerable velocity it is impracticable to bring the exhaust to the atmospheric line, so in a Cornish engine the inside lines cannot come quite together.

The economy of a Cornish engine depends much on the weight raised being adapted to the load, for whatever excess of weight above that required to move the water is raised must be retarded in its descent by partially closing the governor valve, giving resistance under the piston; all excess of weight is lost; whatever space exists between the descending lines represents waste of power.



At times the plungers of these engines fill with water, when the excess of weight requires 5 or 6 pounds per square inch resistance under the piston to prevent it descending too fast.

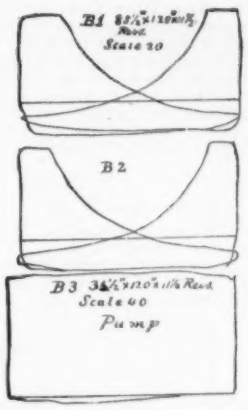
D 1, from the steam cylinder, was taken with these conditions; the descending lines are one-quarter inch apart, equal to five pounds per square inch.

The mode of working these machines is to maintain the water in plunger to the weight required for the correct speed with governor valve *wide open*.

D 2 was taken with this condition, and shows about 1½ pound resistance under the piston, a decided improvement for duty from D 1.

D 3 was taken from the air pump, which at the time had an air leak; when this was corrected cards of the form of D 4 were attained, the usual form from these single acting pumps.

D 5 is from the main pump taken from the lower chamber; shows both the suction and discharge.



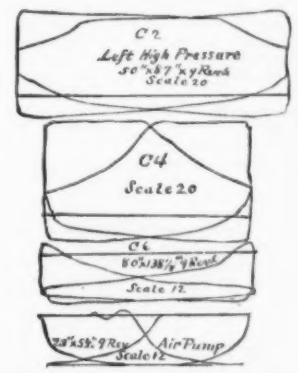
E 1 was taken from the steam cylinder at a time when the pump plungers contained an excess of weight, as shown in D 1.

E 2 is from the same, with the weight adjusted to the requirement of the load.

E 3 is from the main pump. At the time of trial of these machines, soon after their erection, there was difficulty in obtaining true cards from the pumps; in fact, there were never any reliable ones produced, although three indicators were injured in the attempt.

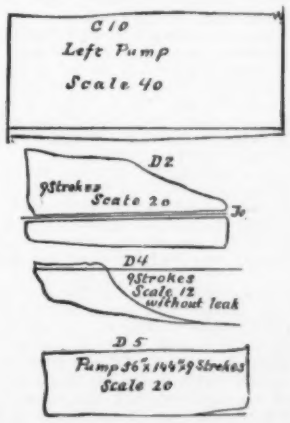
We have since feared gritty water coming into a good indicator; it is extra hazardous (as is the practice of lending these instruments), but the former trouble is happily overcome.

Some time since, when endeavoring to take cards from these pumps, the water was so filled with grit that by the third stroke the piston of the indicator stuck in the cylinder



and would not come down to the suction line. The piston was removed for cleaning and oiling, when it occurred to me that it would be a good thing to fill the cylinder of the indicator with oil; it would remain on top of the water, keep the piston lubricated and grit from coming in contact with it. The indicator cylinder was filled, the piston replaced, and several true cards taken without further trouble; this is a new application of "oil upon the troubled (or troublesome) waters."

F 1 is from the steam cylinder. This is the form of card taken from the engine as originally constructed with counterbalance weights bolted between the arms of fly-wheel; with these weights in the wheel the engines did not run even, and could not be worked slow, stopping when the weighted side of wheel was down. Finding the engine would be nearer balanced without the weight, it was removed.

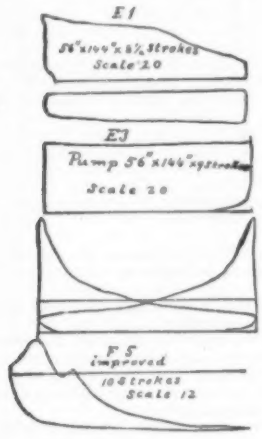


F 2 was the card obtained from this engine after the removal of the weight; the machine can now be worked slower than formerly; the card is even but throttled, owing to the steam cylinder being large for the pumps as compared with the other machines.

F 3 is from the same engine using ten pounds less steam pressure and with the throttle valves *wide open*.

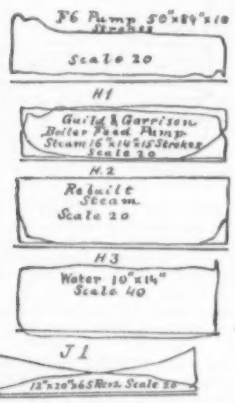
F 4 is from the air pump. This pump, as built, had no room for the waste water; the card shows that the pump, having the same speed as that of the steam piston, discharges its water with velocity so great as to cause the pressure to raise 32 pounds above the atmosphere before the water had time to flow off through the pipes; this caused a shock upon the engine. A wrought-iron tank 2x6 feet that was out of use was placed near the air pump horizontally, and the air pump caused to discharge into and through it, the water having time to flow off during the return stroke of the pump; this entirely remedied the defect, the pump working smooth.

F 5 is the form of card attained from the air pump since provided with the waste-water tank; the lower line represents the down stroke, the upper the discharge; the water strikes the head of pump near the point where the line crosses above the atmospheric line, and flows off through outlet pipe into tank from whence the boiler feed is taken. This engine is provided with an ingenious arrangement for condensation, whereby the gritty water is excluded from the air pump and clear water raised to 120° or 130° for boiler feed, the water being kept separated.



F 6 is from the main pump; not a good card, but true; it was taken with oil on the troubled waters. These pumps are in need of an air chamber near the valves; there is a large air vessel some 40 feet above the pumps, that renders but small relief to them; there has been provided a small air vessel directly over the discharge valves, all that the space would allow; this much improved the working of the machine, but the cards show need of a larger air cushion. The valves for these pumps are not as durable as those in the other pumps. This engine gives a higher rate of duty than the Cornish does. The valve gear and cut-off work admirably.

The following cards taken from direct acting steam pumps do not present the conditions for using steam expansively that the larger machines have. The invention devoted to the direct acting steam pump has been to produce a machine



that would *run* rather than for economy; they were built to supply an important demand, and, used when fuel is plenty, the steam following full stroke, have well served their purpose.

The cards from the three following steam pumps will be designated by the letters G, H, and I:

G 1 is a steam card from a Guild & Garrison pump, 24-inch steam cylinder, 18-inch double plunger, and 16-inch stroke. The pump is placed in the pit of the low service engine house to remove leakage from the pit. The steam is conveyed nearly 300 feet, for the latter third part of the distance through a three-inch pipe; thus the pressure is much reduced before entering the pump, and accounts for the appearance of a throttled card.

G 2 is a water card from this pump delivering into the stand pipes of the large engines; the pump does not thoroughly fill if run at high speed; this card, taken while making 38 double strokes per minute, equal to a piston speed of only 100 feet per minute, shows nearly filled but not regular lines; if run at higher speed they show still more irregular.

H 1 is a steam card from another Guild & Garrison double plunger pump; this one at the high service and used as a boiler feeder. Diameter of steam cylinder 16 inches, plungers 10 inches, stroke 14 inches. This pump was highly finished, but as turned out from the shop could not make a stroke within five inches of the length of steam cylinder, and was wasteful with the steam used to move piston valve, for during part of the stroke it passed direct into the exhaust without being used.

H 1 was taken while the pump was in this condition; these defects having been remedied, the machine gave cards of the form of

H 2, an improvement in looks and duty.

H 3 is a water card from this pump.

I 1 is a steam card from a Knowles bucket pump of the same dimensions as the last; it can be used either as a boiler feeder or a well pump, having separated connections for this purpose; this is one of the early cards taken from this pump.

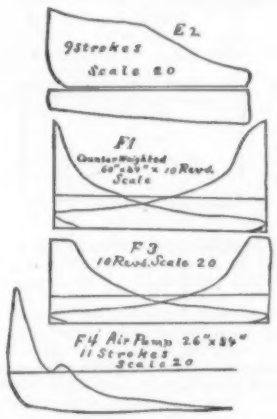
I 2 was one of the last taken from it.

I 3 is a water card from this pump while supplying the boiler.

J 1 card was taken from the machine shop engine, a horizontal, crank, and fly wheel steam cylinder 12"×20", common slide valve with lap to cut off at about 4-5 stroke.

K 1 card is from the high service boilers, and, compared with several of the cards presented, becomes interesting as showing at what loss of pressure the steam enters the various machines.

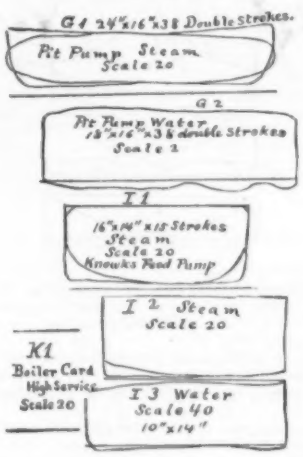
When the highest cards were taken at the high service, a short time since, the steam pressure was just raising the safety valves on boilers (our practice is to carry it but one pound lower); the same indicator and spring that had been used in taking the steam cards was put on the boilers by disconnecting a steam gauge and attaching the indicator; the steam was brought to the safety valve pressure, when motion was given to the drum of indicator by hand and the atmospheric line described; then, admitting steam, motion was again communicated, when the pressure was recorded.



Several cards were taken in this manner, and, measured by the indicator scale, were found to be but 1½ pound higher than some taken from the steam cylinders of the large engines. This trial was performed with care, and is probably free from errors.

CONCLUSIONS.

We have presented you with the cards from a variety of machines, working under very different conditions—the moving of clear and gritty water against high and low pressures, with single and compound, crank and fly wheel, and Cornish engines, single and double acting pumps provided with air chambers and with stand pipes.



Probably no place furnishes a more varied list or a wider range of practice in this line than the St. Louis Water Works.

We have noticed the apparently perfect working of some of these machines, the correctness in their designs and construction, and the mistakes in others. These works, in the main, have been successful, a few things only proving failures and giving much annoyance and expense.

Let it be placed upon record, as a lesson in mechanical engineering, that the works that are *designed and constructed right cause no trouble;* that it is the mistakes in plans, poor material and workmanship that cause future annoyance and extra expense for maintenance and repairs; also that the first cost is not always the most important element in the case, whether it is the question of engineer, engine, pump, or boiler that is under consideration.

Nos. 1 and 2 high service engines, pumps, and valves, with their heavy load and high velocity, are among the most perfect of the machinery of these works. The regularity of motion and the ease of control of these machines is due much to their being completely balanced; the engines are balanced without their load; then moving the same quantity of water on both up and down strokes, and provided with double acting air pump, makes the balance complete.

No crank and fly wheel pumping engine can be as perfect as these without the steam valves of these engines are set with lead to take up all slack connections and keep close to the wheel, not allowing the momentum of the wheel to go ahead of the pressure on the piston.

Increase the lead of *valve* with *increase* of *speed* or *load.*

The small loss of action in the pumps can be accounted for in their having a large valve area with small lift of valve, the true principle for valves of pumping engines.

Decrease the *lift* with increase of pressure.

The quiet working of the valves is due to their having been constructed upon the true principle for pump valves, an important rule, but never published to my knowledge, viz.:

Two pounds of metal to each inch of lifting area of valve.

After taking a great number of cards from the compound engines under different conditions and temperatures, we consider it a fallacy to build compound engines without steam jackets. That steam cannot leave an unjacketed cylinder, travel through pass-over pipe into a larger cylinder also unjacketed, expanding several times, without great loss of heat, admits of no arguments.

We further notice that for a good vacuum an air pump with capacity sufficient for the removal of the *air* contained in the steam and water, as well as the water used for condensation, is required.

Also that an air chamber is a good appendage for a pump, if situated near the valves rather than on the further end of the pump main.

We find in our use of the indicator that it may be used to show a condition not existing in an engine or pump; that from ignorance, design or carelessness it may be caused to record erroneously; that much depends upon the *knowledge* of the instrument and *care* in its application, as well as upon the machine itself.

In skilled and honest hands, admitting the coiled spring not to be absolutely correct, still it is practically so much nearer the truth than in the work of machinists and engine builders that it can be relied upon to correct the machines of the present day.

To steam-users we would earnestly recommend its more general use; its cost is not great nor its application difficult or expensive, but the benefit accruing from its use may be beyond computation. Own an indicator and consider it a part of the engine as much as the governor, that it can be applied whenever required. An engine should never be left after erection or put into use until after the indicator has been applied and revealed the working of the machine.

Let the engineer set the valves and adjust the engine as true as he may by the light that is in him, then *reset* and *readjust* by the light of the revelations of the indicator.

PUMPING DEPARTMENT, *St. Louis Water Works,*
February 6, 1878.

GAS COAL.

By JAMES MACFARLANE.

THE most important requisites of gas coal are, first, that it contain a large amount of volatile combustible matter, or gas; second, that the volatile matter be of a good illuminating power; third, that the coal be as free as possible from sulphur; and fourth, that the coke furnished by the carbonization of the coal be bulky, and at the same time firm, that is, not inclined to be granular.

1. The percentage of the volatile matter in the coals usually employed in gas-making is from twenty-five to forty, and in cannel coal it rises to sixty or seventy per cent., a portion being nitrogen and oxygen. A ton of coal should produce from 8,000 to 9,000 feet of carbureted hydrogen or illuminating gas, or from 4 to 4½ feet per pound, the latter, as is well known, being the product of a fair average sample of Youghiogheny coal. Gas works practically obtain more gas per pound than the chemists in analyzing the coal, doubtless through the re-distillation of tarry matter and its conversion into permanent gas. Besides this, at gas works the measurement is taken at a high temperature, a difference of five degrees changing the volume of gas about one per cent. By using the steam-jet exhaust (a recent improvement) an increased quality of gas is obtained, which would otherwise pass off in little bubbles in the tar.

2. That the gas produced from the coal be of good illuminating power is also very important. The standard of gas in our large cities ranges from fourteen to sixteen-candle power. The standard candle in testing gas is of spermaceti, burning at the rate of one hundred and twenty grains per hour, compared with a standard gas-burner containing five cubic feet per hour. When it is supposed to give fifteen times the amount of light furnished by such standard candle, the gas is said to have fifteen-candle power, or be fifteen-candle gas. But the standard of illuminating power can easily be raised by the addition of a few per cent. of some rich cannel or oil shale, or some substance of the character of albertite or grahamite; for example, from a coal that produces by itself fifteen-candle gas, by the addition of ten per cent. of cannel the gas was raised to the standard of eighteen candles. Many coals which produce gas of a low illuminating standard, but in large quantities, and which coke well, are used as gas coals.

3. It is important that the coal should contain but a small proportion of sulphur compound, as it is then easily purified, requiring less lime, producing a better quality of gas, and the coal may be safely stored without danger from spontaneous combustion. Good gas coal should not require more than one bushel of lime to purify 5,000 or 6,000 feet of gas. The sulphur in coal is sometimes in combination with iron; in other cases it passes off in a volatile state, leaving but little in the coke. For gas-making this latter is a disadvantage, as the less sulphur entering the gases the better, since it must be removed by purification. For the blast furnace, on the contrary, the less sulphur remaining in the coke the better, since it is the sulphur in the coke which is injurious, and not that in the hydrocarbons, which pass off at the top of the furnace stack. In some cases, however, when the gas carries with it most of the sulphur, the gas may be so superior in illuminating power as to warrant its use, notwithstanding its increased cost of purification.

4. A ton of good coal, used in the manufacture of gas, should produce thirty-five to forty bushels of coke, weighing thirty-five pounds to the bushel. The coke is used for heating the retorts, and should burn up clean with but little clinker. There should be a surplus of coke when a large amount of gas is manufactured, besides that used in the gas-house, and this is valuable to the gas manufacturer as a merchantable product, especially in localities where coal of a good quality for domestic and other purposes is expensive.—*Coal Trade Journal.*

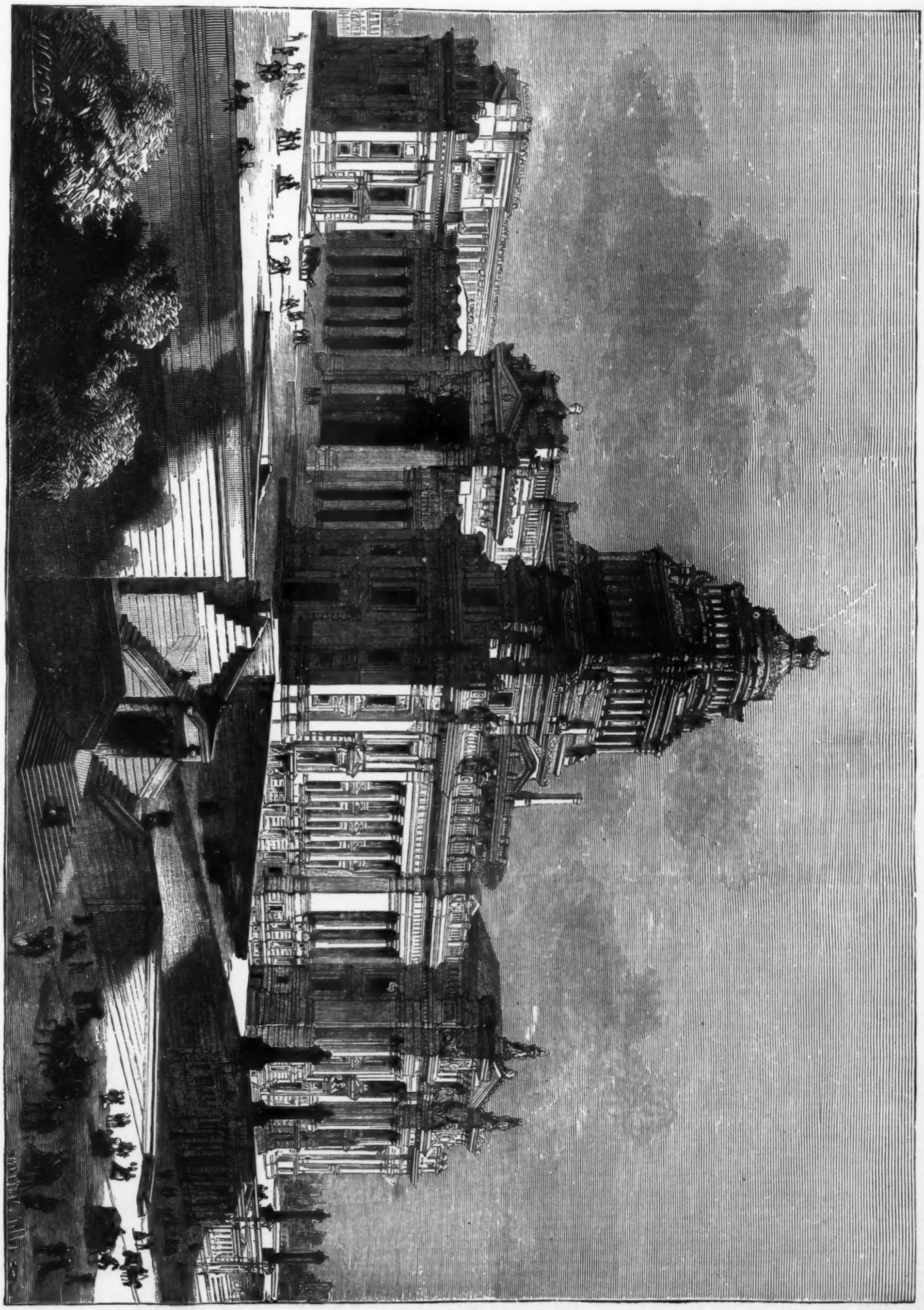
THE NEW PALACE OF JUSTICE IN BRUSSELS, BELGIUM.

THE new Palace of Justice in Brussels, Belgium, when completed, will be, it is said, the most magnificent structure in Europe, the great cathedral of Cologne not excepted. It is located on the summit of the highest hill comprised in the area over which the city extends, and covers a space of nearly nine-tenths of a square mile, the apex of its dome rising to a height of 330 feet. Its shape is that of a parallelogram 640 feet deep by 448 feet in width at the façade.

In front of the latter is a grand stairway leading to a peristyle, where there are twenty massive columns each nearly 6 feet in diameter. From this point the view embraces the entire city and environs.

The style of architecture is Græco-Roman lightly modernized. Every detail, from the great lines of the façade to the finest portion of the ornamentation, is carried out with close regard to the colossal size of the design, so that the general effect is one of perfect homogeneity and concordance. The entrance from the peristyle opens into the Hall des Pas-Perdus, which is 160 feet deep by 60 feet wide, and surrounded by a large gallery at the height of the upper story. The lantern of the dome is 320 feet above the floor of this apartment. The legislative chamber, which lies beyond, is 89 feet deep by 88 feet wide, and its vault extends to the roof. At every story are spacious galleries with which the numerous court rooms communicate. On the right of the central axis of the building is an immense bay in which is another great staircase leading to the different galleries. The ventilation and lighting of the entire structure is said to be perfectly provided for, and four large furnaces supply warmth.

The construction of the building is not yet sufficiently advanced to give a complete idea of its grandeur and architectural beauty, but a good general conception of its appearance may be obtained from the engraving which we present herewith, taken from *L'Illustration*. The architect is M. Poelaert. The work will be finished in 1880, when it will be inaugurated in celebration of the fiftieth anniversary of Belgian independence.



THE NEW PALACE OF JUSTICE, BRUSSELS, BELGIUM.

THE TECHNOLOGY OF THE PAPER TRADE.*

By WILLIAM ARNOT, F. C. S., Edinburgh.

LECTURE VI.

The various classes of Paper: characteristic differences. The determination of the Ash or Loading. Water Supply. General Arrangement and Construction of the Mill.

THE almost endless variety of purposes to which the material is now applied involves the production of papers differing very widely in color, texture, and strength. For bank notes and deeds of various kinds we must have paper that will stand much tear and wear, while for newspapers, which are now considered old twenty-four hours after publication, a paper indifferent both as to strength and color will be quite suitable. We must have strong, heavy manila papers for wrappers and bags, and light, airy tissues to be applied to such varied purposes as making letter books, wrapping up silver plate and jewelry, and for decorations of various kinds. We must also have satin cream-laid note for writing our missives upon, and bibulous paper for blotting and filtering. I do not know that we need go very fully into this subject. We have much ground to cover in this our last lecture, and we must try to apportion our time to the various subjects to be discussed proportionately to their importance.

The papers in every-day use may be classified in various ways. For our present purpose it will be sufficient to look at them as divided into four groups: (1) printing papers, (2) writing papers, (3) wrapping papers, and (4) miscellaneous papers. The first group comprises about one-half of the entire paper manufactured, and, of course, includes products widely differing in their nature. Beginning with newspapers, we have a variety of fabrics into the composition of which may enter esparto, straw, and wood. Made from all esparto, carefully beaten out, and not too heavily loaded, the product may be considered quite equal to all the requirements of a first-class newspaper. Mixed with, say, 7 to 10 per cent. of wood fiber, or 10 to 15 per cent. of straw, esparto will give a fairly good paper for the ordinary run of newspapers, while with larger proportions of wood or straw the strength of the sheet will diminish. Straw and wood by themselves do not give strong papers, but still they are produced and consumed in considerable quantities. The amount of clay introduced will also materially influence the character of the product. A paper made from a short, hard fiber, and heavily loaded, may be considered at the bottom of the scale, both as regards strength and flexibility; the mere look of the paper may be good enough. Next to newspaper papers come common and medium printings; they are intermediate in character between newspapers and fine printings, and are of almost endless composition and tone, to suit the views of the printer and his clients—the element of cost always being prominent. They rarely contain anything of a nature stronger than esparto, and perhaps a little jute. Fine printings are more carefully prepared than the other varieties we have spoken of, the bleaching, pulping, toning, and straining being all very carefully attended to, and the strength of the fabric increased by the addition of from 5 to 10 or even 20 per cent. of strong rags. The beauty of the texture of some of these papers is admirable, and, perhaps more than any other class of machine-made papers, illustrates the perfection to which the art has been brought. It is comparatively easy making beautiful papers when a long price can be got for them, such as will enable the manufacturer to use the finest materials obtainable, but it requires skill and experience to produce the admirable specimens I speak of with comparatively worthless materials and at small cost. The cotton or linen rags to be blended with the esparto are put into the beating engine as bleached half-stuff, and the two materials are beaten up together. The effect of even 5 per cent. of linen upon the character of esparto paper is very noticeable, especially as conferring a considerable degree of strength to the sheet.

In the second group we have writings of all kinds, divisible at once into engine-sized and tub-sized machine-made,

* Journal of the Society of Arts.

BUFFET IN WALNUT, DESIGNED AND MANUFACTURED BY MAZAROZ, PARIS. *From the Workshop.*

and hand-made. The first-named variety differs but little from fine printings, and is produced to meet the popular demand for cheap goods. Engine-sized writings may contain a larger percentage of rag stuffs than printings, and are more heavily sized, as well as more highly calendered. They are generally colored, too, to meet the taste of the consumer. Tub-sized writings embrace a very large variety of papers, differing in texture, weight, color, and marking. Among them we have some of the most beautiful products of the paper-maker's art—made from the finest, whitest, and strongest of materials, beaten so as to retain all their good qualities—strength, flexibility, and elasticity—uncontaminated with mineral matters, beautifully and appropriately water-marked, and surfaced to perfection. In recent times I have been struck with the close resemblance which many of our better qualities of machine-made writings bear to hand-made papers, and it seems to me that, with skill and care, and the same quality of raw materials, machine-made papers need not be far behind the undoubtedly fine product of the hand mould. The better classes of tub-sized writings are produced from various admixtures of cotton and linen fiber. Some of them contain a small percentage of clay or pearl hardening, others starch, either introduced dry or swelled with boiling water, or both agents may be present along with whatever coloring matter may be required to give the paper the requisite shade or tone. Hand-made writings are always of a high quality, made as they are for those who can appreciate and pay for an unexceptionable article. The fibers are drawn out so as to retain as much of the original length as possible, and the peculiar shake which the experienced vatman communicates to the mould causes these to interlace into a strongly felted sheet. Messrs. Hodgkinson and Messrs. Spicer have sent me some specimens of hand-made papers which are simply faultless, while Messrs. Cowan Allan & Annandale have handed me an extensive collection of their machine-made writings, which very well illustrate the remarks I have just made. Account-book papers belong to this group, and differ but little, unless in thickness and shade, from the writings we have been speaking of. Much of the paper used for this purpose is yet made by hand. Artists' papers may also be considered under this head. Complaint has been made that papers cannot now be got that are absolutely trustworthy for high-class work. It is, of course, a serious matter for the artist to find, after he has spent much time and labor in developing his ideal, that the sheet upon which he has been working has lost its flatness and its surface, and is no longer the thing of beauty which it appeared to be. I am inclined to think, however, that if paper ever was produced with all the qualities desired, it can still be produced, and that probably the prevailing cry for cheap goods has not been inoperative in even this department of the trade. I have placed myself in communication with the Messrs. Hodgkinson upon this subject, and these gentlemen assure me of their readiness to consult the views of the profession, and undertake to produce paper that will meet all the requirements of the artist, if some experienced gentlemen will kindly communicate with them, and point out what their wants really are.

The third group embraces papers of the most widely different characters, from the thinnest of caps to the heaviest manilas. The variety here is indeed endless, such as to defy even a passing reference to the various classes in the short time at our disposal. Ropes, manila, jute, and flax waste enter largely into the composition of the stronger and heavier classes, such as cartridges, manilas, hosiery, etc., while sedges, palmetto leaves, rough grass, straw, and esparto figure in the lighter and weaker classes. Clay plays an important part, too, in the composition of some of the cheap, heavy papers; and various coloring matters added to all the classes multiply the varieties very greatly.

In the fourth group is embraced all the varieties of colored and fancy papers, and to these certainly one entire lecture might be profitably devoted; I must for the present, however, leave them untouched.

Boards, which can scarcely be included in any of the groups, are used for a variety of purposes, probably most largely for binding books. The raw materials used in their manufacture are of the coarsest kind; indeed what all other mills reject can be readily used up in the board mill. The machinery involved is much less elaborate than that used in producing paper. The finest boards are still made on moulds by hand, but the great bulk of them are produced on machines resembling the wet end of the Fourdrinier or the "cylinder." The raw material is not usually boiled at all, but is at once put into the engine. The stuff, after being beaten—and, of course, that is an operation that is not carried very far—is run direct into stuff chests, and from these on to the wire of the machine, the refinement of sand-traps and strainers being dispensed with. The board is not made at once by the simple draining of the stuff upon the wire, as paper is, but is made in layers. Stuff of the thickness necessary to produce boards of medium thickness would never drain upon a wire or cylinder, and could not well be made uniform with the rough materials used; the sheet is, therefore, run out very thin, so as to form a sheet something like good, strong brown paper, and this, after passing between the press rolls, winds upon the upper one—which is usually of wood—until a sufficient thickness has been attained, when it is slit up and removed from the roll. The various layers, being pressed into each other while quite wet, adhere and form one solid sheet or board. The roll round which the boards are formed is grooved in several places longitudinally; the grooves serve to guide the knife used to slit up the cylinders as they attain the desired thickness. As the sheets are removed from the roll they are, of course, curved, but are easily pressed out flat upon a table. They are then made up in piles, alternated with felts, and squeezed in the hydraulic press until the bulk of the moisture has been removed. The drying which follows may be accomplished in three ways, either by the air, or on steam-heated plates, or in kilns; or the air process and either of the others may be combined. When they are to be dried by the air they are either laid out upon grass plots or put up in racks. Of course this is a very slow process, and, unless in very small establishments, quite inapplicable. Steam drying is more rapid, but it is also more expensive. Kilns or stoves are just hot-air chambers, in which the boards are arranged in racks. The drying is done rapidly in these, and if care be taken to prevent the temperature rising too high the results are satisfactory. The boards have finally to be calendered, the rolls by which this is done being heated by steam, which enables them to impart a much higher surface to the goods than they would if cold. Before subjecting the boards to the pressure of the calenders, however, they have to be steamed for a few seconds to soften them a little; in fact, the steaming and hot calendering are exactly analogous to the damping and ironing of linen.

We have now to consider the method of estimating the amount of ash or loading in paper. In all well-conducted establishments this operation is now very frequently conducted so as to control the use of loading matters in the mill. Paper-makers, as a rule, quite realize the importance of this, and we are convinced that in many other departments of the trade equal vigilance would be equally repaid. The following apparatus is necessary for the successful and rapid execution of the process: A balance weighing to tenths of a grain, a platina capsule about 2¾ inches in diameter by 1⅛ inch deep, a tripod and pipe-clay support for the capsule, a pair of small tongs to lift it with, a piece of platina foil to direct the hot air into the capsule, a piece of brass wire rounded at the ends, and a good ¾-inch Bunsen burner. The operation in itself is exceedingly simple: 50 grains of the sample torn into small pieces are weighed and placed in the capsule; a convenient way is to balance the capsule in the scales and weigh the paper in it. The capsule and its contents are then placed upon the support over the burner, the flame of which must be controlled so that it will be quite smokeless. By canting the capsule a little and placing the platina foil over it, so as to cause the flame and hot air to play among the fragments, the carbon will be burned off much more quickly than when it is left open. An occasional stir with the end of the brass wire will expose fresh portions of the ash to the oxidizing action of the current. The burning should be thoroughly effected in from ten to fifteen minutes. After the capsule has been allowed to cool completely, it may be placed, with its contents, on the balance, and the weight of the residue ascertained; this, multiplied by two, will give the percentage quantity of mineral matter. Allowance will, of course, be made for the normal ash of the paper. The ash, as a rule, will be quite white, but, depending upon the composition of the paper, it may either be gray or reddish. A good supply of gas should be provided for the burner, or the work will be tedious.

The character of the water supply of a mill very largely influences the character of the paper produced; of course, I do not refer to any water that may be available for power, but to that which is essential for washing and diluting the pulp. To be in every way suitable for the production of the finer classes of paper, this water should be quite bright and colorless, free from all visible impurity, and free also from the dissolved chemical impurities—lime and iron. It is but rarely that we meet with water possessing all these qualities in a high degree. If the supply is obtained from a stream, it may be contaminated with coloring matter derived from vegetable sources, and at certain seasons it certainly will be impure from mineral and other matters washed into it by the rain. To insure a constant supply of known quality from such a source, a reservoir and filter will be necessary. The former should be large enough to contain as many days' supply for the mill as experience has shown necessary to tide over the periods during which the flood water is seriously impure. If the normal condition of the water supply is such as to involve constant filtration, then the filters must be extensive, and so arranged that a portion of the system may be cleaned out at any time, while the remainder is kept at work. For every 1,000 gallons of water required for 24 hours you must have a filtration area of from one to one and a half square yards. The most suitable materials are sand and gravel, arranged in three or four layers, fine washed sand forming the upper stratum. Drain-tiles will, of course, be laid pretty thickly in the bottom; and it is advantageous to have a few vertical air-pipes communicating with the drains; these are especially serviceable when running the water on to the filter for the first time. But the water may be quite free from color and suspended matters, and still be but ill-suited for the purposes of the paper-maker It may be hard, or alkaline, from the presence of lime salts, which will react with the chemicals used at all the stages of the process, detracting from their effect, and involving the use of larger proportions than would otherwise be necessary. Of course the extent of this effect may be but slight, but, on the other hand, it may be serious, depending upon the proportion of lime in the water and the volume of it used in the various operations. There is no good or readily available means of overcoming the difficulty. Chemical agents may be used to remove a portion of the lime and magnesia; but the use of them involves both labor and expense; and it is questionable if the cost will not in every case exceed the gain. When the evil is really a serious one an effort should be made to collect surface water and apply it to those portions of the process where soft water is most desirable. If the water is contaminated with iron it will be quite unfit for pure white papers. The iron is precipitable from its solution by alkalies, and when so precipitated it cannot but affect the tone of the paper. Of course the quantity may be—as, indeed, it usually is—almost infinitesimal, in which case it may be disregarded; but if it should amount to anything like a grain to the gallon its presence must be prejudicial. Hofmann, in his work on paper, says if water contains only one-fiftieth of 1 per cent. of iron it will be prejudicial. As there are 70,000 grains in an imperial gallon, the quantity referred to will be equal to about 14 grains per gallon. If such waters exist at all in the proximity of paper mills, give them a wide berth, as they are utterly unsuited for any but medicinal purposes. Whatever be the nature of the supply or its source, it is always desirable to have a couple of days' supply ahead of the mill in case of accident. This will enable the pumps, necessary when the source of supply is low, to be overhauled from time to time. When the water is pumped direct into small supply cisterns the failure of a pump becomes a serious matter. The quantity of water used per ton of fine printing paper produced should not exceed 40,000 gallons, and if the various precautions as to boiling, washing, and rinsing machine water which I have indicated from time to time be adopted, the quantity will be less than 30,000 gallons. Writings will take more and the lower qualities less.

In the earlier days of the paper trade, water for driving purposes was considered indispensable, and, until comparatively recently, the idea of building a paper mill away from water-power would not have been entertained. The development of our coal fields and railway system, with the introduction of esparto and chemicals, have, however, completely changed the conditions of success. No doubt water-power is at all times an element of importance, but cheap coal, facilities for bringing the raw materials into the heart of the mill, and removing therefrom the finished product, coupled with an abundant supply of pure washing water and a ready outlet for the impure, will go far to compensate for the absence of water-power, if it comes to be a choice between having the one or the other, and not both. The power necessary to keep a 100-inch machine mill going is about 250 horse-power; and no doubt if any considerable proportion of this could be got steadily from water it would be valuable. Water at the best, however, is very fluctuating in amount; and a paper mill, perhaps above all other industrial establishments, requires a perfectly steady power. The steam necessary, independently of what may be wanted to furnish or supplement the driving power, is considerable; and it will often be found that the lower price of coal at one place compared with another will be of more real importance than the existence or non-existence of so much water-power. This leads me to say, in reference to the selection of a site for a paper mill, that due regards must be had to the following among other matters: The possibility of obtaining a copious supply of pure soft water; proximity of railways and the possibility of getting a siding into the work; proximity of port for arrival of esparto; ready supply of good coal at cheap rates; skilled labor available, and house accommodation for the same; disposal of refuse matters, both solid and liquid, without the risk of interdict as a nuisance; and, if you will, available water-power. In constructing a paper mill, the plan should be well considered, so that the various operations, including the moving of materials from one place to another, may be accomplished with the smallest expenditure of labor. It will be remembered that the materials in process of conversion into paper continually descend as they go forward in the mill. They are first put in at the top of the boiler, then discharged from the bottom, next put into the breaking engine over the lip and discharged from the bottom into the poacher, from the bottom of which they discharge into the hydraulic press. At this point there is usually a break into the gravitating process, hoists being used to lift the pressed half-stuff to the level of the beating engine; from the latter it discharges into the machine chests, and thence on to the machine itself. If this hoisting can be avoided, so much the better. It is seldom, however, that a site can be obtained where the whole process will go on without some lifting.

The buildings should all be roomy, with high open roofs, well lit and ventilated. It is a mistake to suppose that work can be either well or cheaply done in dark, confined, ill-ventilated apartments. A better class of workmen will grow up under the healthy influence of cheerful surroundings than in the depressing atmosphere of a close, crowded, and untidy mill. The machine house especially must be well ventilated, and this must be arranged in such a way that there will be no possibility of down-draught, the effect of which would almost certainly be to precipitate blacks and dust of all kinds upon the web, to its permanent detriment.

A large amount of vapor constantly arises from the paper passing over the drying cylinder, and unless this is speedily removed it will condense, and drop from all parts of the roof, etc. Various plans have been devised for the ventilation of machine houses, and some of them have, no doubt, proved very satisfactory. Boyle's ventilator, which works splendidly when there is a good breeze outside, does but little work when the atmosphere outside is still. The Archimedean screw ventilator has been extensively adopted, and gives great satisfaction, especially when driven by a cord from the mill shafting. This insures a constant suction, which would fail in calm weather—owing to the stoppage or slow motion of the screw—if the motion was dependent, as it is in the case of halls and such like, upon the power of the wind to move it. Another system is to have a double ventilating shaft rising from the roof, with the louvre boards so arranged that soot and dust cannot be blown inward.

The steam boilers should be situated having a regard to the easy access of fuel, and the points where the steam is most largely to be consumed. They should be of ample power, so that they will not require to be fired heavily. It is a great mistake, working with insufficient or indifferent boiler power, or with boilers that are not in first-class condition. Steady, careful firing in thin layers, in alternate furnaces, will give very economical results compared with heavy, reckless firing, conducted under the impression that, as the steam is difficult to keep up, the correct thing to do is to pitch on as many coals as possible. Let the quantity of smoke constantly issuing from the chimney top speak to the absurdity of the practice, and also the blacks which a foggy day will inevitably bring down to pollute the product. Mechanical stokers are no doubt very good things, but they are only necessary when men and master are alike careless or ignorant of the principles involved in the combustion of fuel. The exposed portion of the steam boilers, as well as all the pipes leading the steam through the mill, should be coated with non-conducting materials. The sludge settling from machine and engine waters, mixed with a small proportion of rough fiber, makes a very good coating agent. The boilers should be blown down a few inches every shift, especially if the water is in any way hard; and they should all be insured, much more for the sake of the systematic inspection which that involves than the securing of a few hundred pounds in the event of their blowing up.

Fires, unfortunately, are not uncommon in paper mills; provision should therefore be made so that, in the event of such an accident, the flames may be extinguished as rapidly as possible. This is all the more necessary when the mill is situated at a distance from public fire appliances. Fortunately the existence of the mill itself implies the existence of an abundant supply of water, and arrangements should be made so that the whole of this may be readily available the instant fire is discovered. Force-pumps in various parts of the mill should have connections and off-takes for hose-pipes, so that, whatever their purpose usually, they may, by simply opening a few taps, at once begin to drive water wherever it may be required; a manual engine is also useful, as well as buckets, placed all over the mill, which should on no account be used for any other purpose. When it can be done conveniently, a very good plan is to have special water mains all over the mill, with numerous off-takes and a full supply of hose-pipes, the system being connected with a set of force-pumps, worked by a little turbine, and drawing from the river.

The success or failure of a paper mill will very largely depend upon its management. There is nothing that will so much contribute toward the prosperity of an industry of this kind as an energetic, progressive, and discerning manager, one who not only knows his work, but finds his chief pleasure in keeping both men and machinery moving sweetly; one whose mind is not a fossil, incapable of appreciating and yielding to altered conditions, but ever on the alert, seeking to develop and improve, and willing to accept improvements on fair evidence, even though the ideas have not been born in his own mind; one who can be at home with his men and yet retain his position among them. He does not require to be a genius, but thinking, active, intelligent, and attentive; to such a man "brocke," and "retree," and "lost time" are hateful terms, and indolent and careless workmen a nuisance not to be tolerated. Such a manager should be appreciated and encouraged, and that their number may be increased, opportunity and encouragement should be given to intelligent young men to prepare themselves for such positions; they should be stimulated to study and attain a knowledge of the principles involved in the various parts of the industry, and to go forward to the Society's examinations until they have passed the "honors" stage. Young

men holding certificates to that effect ought to develop into well-qualified managers.

In drawing this course of lectures to a close, I may mention that my attention has been called to a new method of working machine vacuum boxes which has been patented and applied by Messrs. Mason, Wolstenholm & Spencer. The appliance is simple, consisting as it does of a steam jet acting as an ejector. This neat device takes the place of the usual pump, and is said to give very good results. The advantages claimed for it are that it maintains a steadier vacuum and allows of more water being run on to the wire with the pulp, the practical result being more uniform paper with less "brocke." I have no doubt at all as to the efficiency of the arrangement; it is simple in construction, steady in its action, and easily kept in order, but I suspect it will be found to consume a considerable amount of steam.

My attention has been directed to an interesting historical fact with which I regret I was not earlier acquainted, but which justice to the memory of one who virtually sacrificed both his fortune and his life in working out the appliances now in common use for surface sizing and drying compels me before closing these lectures respectfully to notice. About the year 1842 Robert Gill Ranson, of Ipswich, invented and patented the appliances referred to. Previous to that time the endless web made on the Fourdrinier machine had to be cut into sheets before it could be sized and dried; the labor involved in so doing can be imagined. Since Mr. Ranson's death in 1843 the drying machine has no doubt undergone a great development, but both the sizing and drying machines of to-day are essentially those which Mr. Ranson left behind him, which is a testimony to the correctness of the principles which he set himself to work out.

I have also to express my indebtedness to many friends, both in England and Scotland, for kindly supplying me with specimens of their produce, and information as to their manufacture, and to others for invitations to examine their processes, which I regret it has been quite out of my power to accept.

Many questions of a technical nature—chiefly chemical—have been addressed to me since these lectures were announced, some of which I have replied to in the course of the lectures, but to others I have not been able to give satisfactory explanations, and for this reason, that the subjects, though of great practical interest to the paper-makers, have, so far as I can learn, never been properly investigated.

Among the subjects to which I refer are: First, the nature and origin of, and cure for, quite a variety of specks and spots, some of which appear and disappear in the most unaccountable way. That, in some cases, the specks are due to the presence of the uncombined resin precipitated by acid aluminous cakes, I have little doubt; others, again, are clearly of an oily or greasy nature, while to many more it is very difficult to assign an origin. Of course I do not refer to specks that are clearly traceable to ill-prepared fibrous substances; the origin of many varieties of such impurities is usually not difficult to trace. Second, what effect the sulphate of alumina or alum exercises upon the paper apart from precipitating resin-alumina—that is, supposing an excess of these agents to be used. As a rule, I find that excess—and in some cases very large excess—is used, and the most diverse accounts are given as to the reason of this and its supposed action. Some say it cleans the fibers, but I rather think the time for cleaning the fibers is quite gone by the time the alumina is usually introduced. Starch and clay and coloring matters have all been added in order that they might adhere to the fiber before the resin soap is introduced to coat them; and how, after these and the soap itself have been added, a little sulphate of alumina can do anything analogous to cleaning, I cannot guess. I would have it to be considered, too, that sulphate of alumina is extremely soluble, and that any such remaining undecomposed in the pulp as it goes down to the machine must be diluted along with the pulp, and all but the merest traces of it pass away with the water through the wire. Third, how best to preserve and clarify animal size. I understand that one or two makers know all about this, but choose to keep the information to themselves, which, of course, they have a perfect right to do, although it is somewhat contrary to the spirit of the age. Fourth, the great loss which some rags sustain in the boiling and bleaching processes, notwithstanding their being of almost pure cellulose. Apparently fine white linen or cotton should lose little or nothing by either process, yet we find, even allowing for the moisture and glutine, a very considerable reduction. Fifth, many questions concerning the re-use of machine and other waters, etc.

Such investigations involve much time and expense, and, I am afraid, will not be readily undertaken by competent men unless paper-makers themselves combine to have the experiments carried to a satisfactory issue. The chemistry of the art is doubtless yet in its infancy; indeed, it is little more than half a century old; and although that period has been one of enterprise and inquiry, it cannot be said that in this, any more than in most other of our leading industries, much progress has been made in the way of elucidating the principles involved in the various operations. The pressure of the increased competition and lower prices of the last few years has, no doubt, led to some inquiry in various departments, with results which may be regarded as a foretaste of what might be expected to flow from an exhaustive study of the subject.

The mechanism of the paper process has undergone a more satisfactory development; ingenious engineers have improved the appliances to such an extent that there is apparently little further to be desired. We do not doubt, however, that many further improvements will be worked out as time goes on.

The difference in the two departments—chemical and mechanical—is that in the former improvements in the application of the agents supplied by the chemical manufacturer fall to be worked out by the paper-maker himself; the manufacturing chemist may improve his own process of production and cheapen the product, but he can do nothing more for the consumer. On the other hand, engineers devoting themselves entirely to paper-mill work strive to improve their appliances and meet the wants of the manufacturer as they arise. In short, in the chemical department of his profession the paper-maker is left to make his own discoveries and improvements, whereas in the mechanical he has simply to indicate what his wants are, and forthwith unexceptionable appliances are provided for him.

That the chemical operation of a paper mill should be as well understood and under as complete control as are the mechanical operations, there is no room to doubt, and, as time advances, this will be more fully realized and given effect to.

My attention has been drawn to the circumstance that in my third lecture I have transposed the speeds of the breaking and beating engines.

SEWING SILK.

WHEN Elias Howe invented the sewing machine, he very likely had not the remotest idea of the extent to which it would revolutionize many trades. Irrespective of its having almost created the extensive industry in ready-made clothing, both for male and female wear, it has given rise to a number of inventions having totally different applications to this most ingenious machine. Many trades have been completely changed through its agency, as, for instance, the boot trade; while our fathers had their boots made to measure by the nearest cobbler, who perhaps seldom rose to the dignity of a shopkeeper, we, at the present time, select from a large and varied stock, all made to certain standard gauges and sizes, and turned out in a superior manner by shoe factories or mills, employing often many hundreds of hands. The same applies to the clothing manufacture, where mechanical appliances are used even for cutting out. Who would have thought, a quarter of a century ago, of sewing by steam-power? Yet such a thing is now of common occurrence, and many such establishments are situated not more than a mile from our desk.

The development of this trade has necessitated one important item, not in existence before, viz., an even thread, which should run without hindrance through the eye of the needle, of such a consistency as not to curl up while the shuttle passes through it, and which should also be of great length and without knots, so that a machine, once started, could run a considerable time without the stoppages and breakages uneven thread would entail.

In hand sewing, a knot was of no consequence, for the sewer would simply break the thread, and commence anew. The old bobbins hitherto in use, with a length of 100 to 200 yards, or even less, had to give place to larger ones, holding from 500 to 1,000 yards, according to the kind of thread. The manufacture of these longer lengths without a knot may at first appear not very difficult, but a closer examination of the *modus operandi* of the thread manufacture will show that many of the older arrangements did not suffice, and consequently, had to be altered, requiring new machinery and much scheming in its invention. The manufacturers of cotton thread, borrowing an idea from the weaver, are now making complete warps of the length of yarn they require. These warps they readily size, or starch, the single threads being afterward divided, and run upon bobbins, so as to obtain them all in one full length to the required dimension.

For sewing machines, cotton yarn is, of course, used to the greatest extent; but for many purposes, especially in the boot trade, it is not strong enough, and linen or silk has to be used instead. The latter is gaining ground every day, but has, so far, not attained its proper place as the thread material for mechanical sewing, because it is difficult to make great lengths of sewing silk without several knots; nor has the silk that evenness so prominent in cotton thread, and which is of such vital importance for easy sewing, especially when the machine is driven at great speeds by steam.

How these defects arise became conspicuous when lately, on a visit to the quiet Staffordshire town of Leek, for years the main seat of the sewing silk trade, we examined the mode of its manufacture. Although the main object of our journey was to inspect some new silk thread machinery invented by Mr. Trafford, of that town, and which we will shortly describe, we give a description of the thread manufacture as ordinarily carried on, in order that our readers may be enabled, by a comparison of the two methods, to see the extent of the advances which Mr. Trafford has made in this industry. We had introductions to several mills, but not a little difficulty in finding them, for, singularly enough, most of them were down a narrow entry, or up the backway to cottages, just as if, having heard of their larger brethren in the Lancashire cotton trade growing into splendid palaces, they were ashamed of their more moderate dimensions, and offered a kind of apology for their very existence.

This apparent modesty we found, on entering, not to be without reason. Antiquarians delight in hunting up anything appertaining to past ages, and now out of date, but we doubt whether any of these gentlemen ever explored such a field as ourselves when looking round the mills at Leek. Knowing as we did the highly finished machines used in the cotton, woolen, and linen trades, the care bestowed upon silk throwing and weaving machinery, and the value of the beautiful material used, we certainly were a little dumbfounded to find that sewing silk was made in a *Rope Walk!* This may appear amusing to some of our readers, but such is the fact. As the yarn was made one hundred years ago, when spinning machinery, self-acting stop motions, and accurate workmanship were unknown, just so is the greater part of the manufacture of sewing silk to this day.

We need hardly say that the silk used for sewing purposes is the same as that used for dress goods, which arrives in hanks or bundles from China, Bengal, Japan, and even from Italy, though the latter, being of the best quality, is more used for piece goods. From the hank it is reeled upon bobbins, like all silk, to be "thrown," and then handed over to the "rope walk," which, by the bye, is a long room in the mill, naturally taking up much space. The whole machinery consists, first, of a strong framework, about a yard high, and the same in width, containing a certain number of iron hooks placed horizontally; this stands at one end of the room. Opposite to this, at the other extremity, and about twenty-five yards distant, is another machine, consisting of a movable platform of about three feet square, running easily upon wheels; the platform supports an upright post about two yards high, which, at its upper end, carries what appears to be a target, but which in reality is a hoop, a yard in diameter; this hoop contains twenty-five to thirty, or more, small hooks, set into its face; each hook, being fixed to a small shaft and pulley, can be revolved; in the center of the large hoop is a smaller one, containing a groove, around which, and around each of the small pulleys, a cord is carried; the smaller hoop is turned by means of a band or gearing from a handle, so that when the latter is turned the small hooks revolve, each one around its axis. The operator takes four bobbins and attaches the four threads each to one of these small hooks, by making a loop and knot; a boy now places the bobbins upon an iron rod, and runs with them to the other frame, where he passes each thread over one of the hooks, and returns to the circular frame, where again the same threads are fixed by knotting to four other small hooks, and afterward cut. Next, four more hooks are taken, and once more four fresh threads attached, again being taken to the other hooks, and passed back and attached to four other hooks as before, and so on until the required number of hooks are filled. The operator now turns his handle, and thus "spins" the hooks, giving each thread a certain amount of twist; he then removes the threads in turns, and puts three or four together on one hook, and again twists them. This twisting finished, the number is once more reduced by gathering them together, until gradually the whole number is twisted into one, two, or four threads, as may be desired. The twisting of the yarn is now finished, but one important operation is still wanting, viz., stretching, the object of which is to equalize the twist and give it elasticity. The boy collects all the threads from the square frame in his hand and runs a few yards back with them, then returning to the frame to stretch it again, after that going back to the circular frame; while he is running back the other ends are attached to a reel placed between the two frames and wound upon this as he comes back. When filled these reels are taken to men sitting before the windows, who "clean" the yarn with nippers; it is also slightly singed with gas, and is then ready for the dyer. We have omitted to mention that, while the yarn is being twisted, the frame and platform is wheeled in a little, to allow for the contraction, just as a mule carriage runs a little during twisting. Primitive as the whole proceeding is, it answered as long as great accuracy of counts and great lengths were not required—both very important items, but difficult to obtain by this process.

With fiber generally, such as cotton, flax, wool, etc., by carding, doubling, and drawing, even yarn of almost any lengths or counts can be spun; but this procedure is inapplicable with silk, because of the very great length of the web. The worm, when "spinning" the cocoon, often makes from 500 to 1,200 yards without a break; if this could be reeled off and sorted singly much would be gained; such is, however, never done; the cottagers or small establishments which reel the silk from the cocoons generally run two or more fibers together, so that the silk as imported is not a single thread, but already a doubled or trebled one, and for this reason uneven to begin with. But not only are the different fibers from different worms unlike in thickness, but even the single fiber by itself is not uniformly round. The animal "spins" it as a liquid, which congeals, and being irregularly wound upon the cocoon is in some places round, in others flat, and often the flattened side changes from one direction to another. These causes render it difficult to produce even thread, to attain which, as much as possible, the professed numbers of yarn are sorted together, and examined through a small counting-glass before placing them on the twisting frame. In order to avoid too great a variety the long lengths of single yarn are cut into pieces of about 50 yards. Here we have a necessary operation, but at the same time for present wants an anomaly. We want, say, 500 yards; so we take a hank holding perhaps several thousand yards and cut this up into lengths of 50 yards, and afterward knot them together again! This not only occasions a loss of thread, but also makes nine knots in the whole length.

By this proceeding the yarn is equalized to a certain degree, but is far from being of an even thickness or number; and, as sewing silk is sold on bobbins holding so many yards, it is clear that when uneven and coarser than required, so much silk is lost which has been paid for by the pound. We have, therefore, by the old process loss by unevenness and incorrect numbering, and loss through being cut and reknotted, the latter being computed at about 1½ per cent., and to this must be added the inconvenience to the user.—*Textile Manufacturer.*

PHOTOGRAPHIC PRINTING PROCESSES IN THE SERVICE OF THE PORTUGUESE GOVERNMENT.

By JOSE JULIO RODRIGUEZ.

1. *The Preparation of Negatives from Linear Drawings.*—Here, as everywhere else, the first and most important condition for the successful pursuit of an industry is simplicity.

With all the collodion, silver baths, gold baths, etc., for which we have so many and so various formulæ, there are only a few capable of being used in a great institution, particularly in one where work must be executed within a fixed time and under special rules and circumstances. For the photographic reproduction of a linear drawing which has no half-tones the ground of the negative must be perfectly opaque, the lines, on the other hand, quite transparent. Only a few operators are successful in this, though upon the production of a perfect negative of this kind the whole question of photo-lithograpy and heliographhy depends.

One method of working is as follows: Two baths are used for cleaning the glass plates, a solution of caustic soda to clean off the fatty and resinous particles, and a mixture of a weak solution of bichromate of potash and sulphuric acid for removing all other impurities. The plate is next washed and wiped dry with a linen cloth, when it may be placed ready for use. Any remaining traces of impurity can be rubbed off with a little French chalk and spirits of wine.

The collodion is made in quantities of from ten to fifteen liters at a time. When iodized with the cadmium salt it remains good for months, but is only adapted for copying linear drawings which have no half-tones.

The silver bath is weakly acidulated with nitric acid. For large plates troughs of ebonite with covers are used.

After exposure in the camera, as much pyrogallic developer is poured on the plate as will just completely cover it; and it is then placed on a stand, which can be leveled by the help of three screws. After this, another dose of the developer, to which a few drops of four per cent. silver solution has been added, is poured on it, and this is made by a gentle motion to flow backward and forward over it, until the negative is everywhere equally intense.

It is then fixed with a saturated solution of soda, again washed very carefully, and a saturated solution of mercuric chloride poured on it and allowed to act till the whole film has become white. After a third washing it is covered with a very weak solution of potassium cyanide, which blackens the film.

If the time of exposure be correctly judged, the result will be most satisfactory; though after the blackening with potassium cyanide, and another washing, it may be still further intensified with pyro. and silver.

The varnish has a particular composition.

Positives for the heliography of copper plates are produced by tannin plates and an acid developer.

Most negatives, either before or after printing with gelatine containing glycerine, are taken off the glass and kept between smooth cardboards.

FORMULA.

Collodion Cotton.

Sulphuric acid, 66°	500 grams
Nitric acid (sp. gr. 1·4)	250 "
Cotton wool (which has been washed in a weak solution of caustic soda and afterward well dried)	20 "

The temperature of the water bath must be 60° C. and the time of immersion seven minutes.

Collodion for Linear Drawings.

Alcohol (40° Cartier)	500 c. c.
Ether, 65°	500 "
Collodion cotton	11 grams.
Cadmium iodide	6 "
Ammonium iodide	5 "
Ammonium bromide	2 "

Developer.

A—Distilled water	1 liter.
Glacial acetic acid	20 grams.
B—Pyrogallic acid	100 "
Alcohol, 98°	1 liter.

Mix 1 liter of A with 50 c. c. of B.

Fixer.—Saturated solution of fixing soda with a few drops of ammonia. This must be prepared some days before using.

Varnish (buy hard and capable of withstanding heat).

Alcohol 95°	4 liters.
Orange shellac	360 grams.
Oil of lavender	100 "
Turpentine	80 "

To be laid on warm.

Varnish (for alcoholic collodion which has been prepared with soluble cotton).

Alcohol, 95°	6 liters.
Gum elemi	80 grams.
Benzoin	240 "
Orange shellac	240 "
White shellac	120 "
Turpentine	160 "

2. *Artificial Negatives for Photo-zincography and Heliography.*—On a well-cleaned glass plate is spread a layer of the following mixture:

Gelatine	8 to 10 grams.
Water	100 "

Carbonate of lead as much as will make the mixture to a paste.

The lead salt must be ground quite fine, and be perfectly free from grit. Rub the mixture for some minutes on a colorstone, and apply it to the glass plate with a brush; it must be equally distributed, that no transparent places may be seen. Allow the layer to dry in the open air or at a gentle heat. Now lay the plate on black paper, and with a needle scratch in the drawing, which must first have been transferred to the layer of tracing paper. Retouching is done with a brush and white color. After brushing off the dust raised by the needle, immerse the plate in hydrosulphuric acid, when the white will be turned to a dark yellow. Then let it dry at a gentle heat, and varnish with negative varnish.

The negative is reversed, as it must be in a direct process of typography for photo-engraving. By printing over each other different negatives, produced either by hand or machine, we can obtain combinations very difficult of imitation; the process recommends itself, therefore, for printing bank notes and other papers where forgery may be apprehended.

STEREOSCOPIC TRANSPARENCY PRINTING—MR. BREESE'S METHOD.

By JOHN HARMER.

THOSE who are acquainted with the best of Mr. Breese's stereographs will probably expect to read something novel in an account of his process, and will, doubtless, be surprised when they find that the formulæ he employed, and by which he produced so great a variety of effects, were very common, having been repeatedly published a few years ago. To many photographers the subject I am about to treat of will, to a certain extent, be a new theme; so, perhaps, it will be as well to begin at the beginning, then if there be a fault it will be rather that of saying too much than too little. I propose to deal first with the formulæ, apparatus, and accessories, and to follow them with some remarks on manipulation, which I shall endeavor to make clear by describing various kinds of effects, and how obtained.

The first thing requiring consideration is the *glass*. This should be of the French kind, which is nearly colorless and very thin; it can be procured, both plain and ground, through Messrs. Marion & Co., or a commission agent in France. Great care must be taken to store it in a dry room, or something like a decomposition takes place, which so softens the surface as to make the glass utterly unfit for the purpose. It is best cleaned with a mixture of carefully prepared tripoli or rouge in spirits of wine, followed by the application, with a tuft of cotton, of a little old collodion to which a small quantity of water has been added, the final polish to the surface being given by the removal of this with an old silk handkerchief. Substratums must not be resorted to, as the operations and result are too delicate for anything of the kind to be successful.

The *collodion* most suitable for general use is a ripe sample of simple iodized, such as used to be supplied by the first-class makers for the old-fashioned pyrogallic development, that made by Mr. Thomas being especially good. For special classes of work one or two other kinds are necessary, but more about those when I come to the circumstances requiring their use.

The preparation of the *nitrate bath* is as follows:—Dissolve three ounces of pure triple crystallized nitrate of silver in twelve ounces of distilled water; iodize this by the addition of two and a half grains of iodide of potassium previously dissolved in a dram of water. After a thorough shaking, pour the strong solution into the remaining twenty-four and a half ounces of water necessary to reduce it to the strength of thirty-five grains per ounce, filter twice or thrice through same filter paper; test for free nitric acid, which, if present, carefully neutralize with oxide of silver; filter again, and acidify with from eight to ten minims of glacial acetic acid; this latter should be of the utmost purity, otherwise it will prove a source of much trouble. When great richness of tone is desired, the formation of acetate of silver in the bath by the addition of two or three grains of acetate of soda will be found to contribute toward its production. A caution respecting the use of this bath, especially with the last modification, is necessary to those photographers whose experience has been wholly confined to the use of nitric acid for acidifying. It is exceedingly sensitive to dust and dirt; many kinds of spots, streaks, and comets make their appearance that one does not see when using the hardier bath commonly in use at the present time. Care in preparation and cleanliness in manipulation will, however, be amply repaid by the absence of these defects, and the delicate beauty of the results in other respects.

The *developer* for all purposes of printing is composed of—

English pyrogallic acid	12 grains.
Glacial acetic acid	¼ ounce.
Water	4 ounces.

the bottle containing it being labeled "strong." An ounce or two of this is poured into another bottle labeled "weak," and is diluted with one and a half or twice its amount of water. In cold weather, the amount of acetic acid may be reduced to two-thirds the quantity given above.

The *fixing solution* should be of cyanide of potassium about seven grains per ounce in strength; have in readiness, on the same shelf with this, a ten-grain tincture of iodine for use in the production of atmospheric effect, and for the removal of what is unnecessary in any transparency.

The *toning* of the slides is accomplished by one of the following solutions, according to requirements of subject:—A one-grain per ounce of the developer as given above, a very weak solution of bichloride of mercury, and a solution of—

Chloride of gold	1 grain.
Water	8 ounces.

Many others have been tried, but were ultimately abandoned because of the fugitive nature of the effects produced. The only doubtful one retained is the bichloride of mercury; this, if a weak solution be used, followed by copious washing, does not occasion much cause for complaint; the beautiful blue tone it imparts to moonlight effects cannot be surpassed.

The *varnishes* required are of two kinds, viz., a transparent one for the front glass or glasses of the transparency, and a ground glass substitute for the back one. Amber varnish, composed of gum amber dissolved in methylated chloroform, is most suitable for use in the first instance, being very free from structure. A few grains of white wax dissolved in this (as I have before stated) deadens the surface considerably finer than the finest French ground glass, and for the back one answers the purpose very much better.

Such are the formulæ—very antiquated, some perhaps will say, almost like reading a page of the early history of photography, but, nevertheless, I think I may venture the assertion, after extensive observation, that the results produced by them have never been approached. Difficulties must be expected, for much depends on manipulatory skill; there are none, however, that will not be soon overcome by a little painstaking thought and practice.

A few accessories are necessary in printing which perform the duties of, and are much of the same character as, vignetting glasses; these are termed masks or "shades." In combining clouds having a chimney pot or other foreground with a sea view there will, of course, be a necessity for a delicate softening off of the cloud from the pots upward, as likewise with the sea view from its horizontal line into the sky, an even tint resulting when the two softened edges are superposed. For each of the above negatives a mask would be required, opaque at one edge, this opacity being gradually reduced to transparency at the center of the glass. The best known method for obtaining one of these masks, perfectly graduated as specified above, is to procure a sheet of white blotting-paper on cardboard, and roll about half of it into a good sized cylinder, under the edge of which place a sheet of yellow tissue or other paper, and spread out upon that part of the paper unrolled. When this contrivance has been fastened with clips or pins, and placed facing a high side or other suitable light, with its flat yellow surface upward and in a horizontal position, it will be observable that the yellow reflected on the lower portion of the cylinder merges by imperceptible degrees into that of the upper of white. If a photograph of this be taken, out of focus, with the twin lenses of the binocular camera so placed that the center of the roll may occupy the center of the plate, as well as fill it in length, it will, if conditions of light were right, be all one can desire. Masks for printing colored glasses from can be made by placing two of the above face to face with the opaque side to the opposite edges, the center being left quite transparent. These can be again copied for one opaque in the center.

When the landscape is of very irregular outline, a piece of blackened cardboard is necessary, upon which temporarily fasten a rough paper print of the landscape, and cut out the cardboard to the outline. During the exposure of the cloud selected for the picture, use the shape to screen the light from those portions not required, taking care to move it up and down sufficiently to prevent any hardness. With the help of a mask already adjusted on the negative nothing need be allowed to print hurtful to the finished effect. This is what I designated in a former letter as "wafting."

Another kind of mask is one used for printing circular holes. For this a piece of cardboard a foot or so square should have painted in black upon its center a good sized six or eight pointed star; the points should be wedge-shaped, and of considerable length; the longer and finer these are, the greater will be the softness produced. A pin having been driven through the center of this drawing to spin it upon, it is ready to be photographed out of focus, and while spinning at a quick rate.—*Photographic News.*

IODIDE OF POTASSIUM IN ASTHMA.

THE Paris correspondent of the *British Medical Journal* writes: For nearly twenty years back M. Sée has been employing the iodide of potassium for the cure of asthma; and, according to his experience, it may be looked on as a specific for the disease, if there be such a thing as a specific in medicine. It is true that others had employed it, and are still employing it, in this affection; but, as it is invariably prescribed with other substances, such as ipecacuanha, opium, belladonna, ether, etc., it is difficult to say to which to attribute the curative effect. M. Sée has had the idea of trying the iodide of potassium alone, which has been followed with the happiest results. He prescribes it not only during the attack but enjoins the patient to continue it for weeks, months, or years, according to the severity or duration of the malady. In exceptional cases, he combines it with a little opium, to prevent iodism, and, when the breathing is greatly compressed, with chloral. During the paroxysm, however, M. Sée employs the iodide of ethyle, a substance discovered in 1825, by Guy-Lassac, and composed of iodine and ether, the new compound possessing the respective properties of both these substances. He administers it by inhalation, and he has often found that a single dose of five or six drops has been sufficient to cut short a paroxysm. The breathing once relieved, he then trusts to the iodide of potassium to effect a cure. The above treatment has been found useful in all cases of asthma, whatever its origin; and the iodide of ethyle has also proved efficacious in relieving cardiac and laryngal dyspnœa.

LECTURE ON METALLOSCOPY AND METALLO-THERAPY APPLIED TO THE TREATMENT OF GRAVE HYSTERIA.

Delivered at La Salpétrière, Paris, by Professor CHARCOT.

WHAT is metallo-therapy? I shall be brief on the subject, but I hope to be able to say all that I know in connection with it.

First, we must distinguish external metallo-therapy from internal metallo-therapy. External metallo-therapy is the first in date. It consists in applying metals on the bodies of sick persons. Internal metallo-therapy, on the contrary, consists in the internal administration of metals, the previous external application of which has produced certain significant results. So that, as you see at first glance, there is, as it were, an abyss between the two kinds of metallo-therapy. Presently we shall be able to judge whether this is simply apparent or real.

Before entering further into the particulars of metallo-therapy I must say something of metalloscopy, which is, so to speak, its preliminary and preparatory part. I will consider the employment of metalloscopy and metallo-therapy only in connection with hysteria, although, according to M. Burq, they may be applied to other diseases. Take a case of hysteria to be treated by metallo-therapy, and the question is to find out a metal which will produce certain phenomena in the patient, and which, according to M. Burq, is consequently the metal suited to the condition of the patient. Thus metalloscopy is nothing but a search for a metal which will have a special action on this hysterical patient, and more particularly on the phenomena of amyosthenia and anæsthesia which she presents. All these facts, as well as the theoretical idea connected therewith, are due to M. Burq. It is true that formerly metals were applied to hysterical subjects for therapeutical purposes, but no system had been constructed, and it was not known that there were metals which could exert a specific action suited only to a certain number of cases. How is it possible to make out this special and appropriate metal? First, you try the metal which most commonly succeeds in modifying certain hysterical phenomena, and this metal, according to Dr. Burq, is iron. Then you test successively the other metals, gold, copper, zinc, tin, etc., if you have failed with the first. The experiment is carried out in the following manner: A patient with left hemi-anæsthesia, for instance, is taken, and by running a needle through the skin you find that there is no sign of sensibility. Then you apply to the anæsthetized side, generally on the arm, a piece of metal—gold, for example. There is no need of any special apparatus. If you apply gold, you may take two or three napoleons tied to a string and maintain them in contact with the skin. This is what you afterward notice: If the patient is sensitive to the metal selected (in this case we suppose it to be gold), after a short time, varying from a few seconds to fifteen or twenty minutes, the patient will tell you that she feels her arm numbed, and then, if you prick the skin with a needle in the neighborhood of the metallic application, you notice that sensibility begins to return. It is the first stage of the successive disappearance of the abnormal phenomena, and, among others, of anæsthesia. You notice, also, that the skin has got red in the neighborhood of the application, and the punctures, which were bloodless before, begin to bleed freely. Furthermore, if, before the application, you make the patient squeeze a dynamometer, you find a very low figure, 30 or 40 pounds perhaps, as hysterical anæsthesia is always accompanied by amyosthenia. But, after the metallic application, you will see the patient mark 60 or 80 pounds with the dynamometer. She has, consequently, acquired the strength of a man. Amyosthenia disappeared with anæsthesia. These are facts which we have repeatedly demonstrated in the presence of MM. Luys, Dumontpallier, a Commission of the Société de Biologie, and a great many other medical men who took an interest in our experiments (among them Claude Bernard, Béclard, Bert, Bouley, and Vulpian).

Now, either you continue the experiment after the recurrence of sensibility or you do not. If you go on—I mean, if you keep the metal applied to the skin—you will soon see a very singular phenomenon, to which I call your special attention. If you continue to prick the skin with a needle, you perceive at a given moment that the sensibility which had returned has again gone off. Anæsthesia shows itself once more with its previous character, and is sometimes even more intense than before the application of metal, so that it happens that, whereas there was only analgesia before the application, you may notice complete anæsthesia after the experiment. This is a phenomenon which you will witness under other circumstances and in an independent form. M. Burq has called this anæsthesia "*l'anésthésie de retour.*" If, on the contrary, you take away the metal as soon as you have obtained the recurrence of sensibility, this sensibility persists for several hours, and sometimes for one or two days. Moreover, the sensibility becomes general. Thus, you had seen sensibility return only in the arm; you soon see it extend over all the side of the body which was affected with hemi-anæsthesia before the experiment. But this is only a temporary phenomenon, and the patient soon relapses into anæsthesia.

Another phenomenon that I will show you presently, which was unknown to M. Burq, and which is of a character to demonstrate that all the phenomena which I am now relating cannot be explained by the condition English physiologists sometimes designate by the name of expectant attention,* is a phenomenon which I will call transfer phenomenon (*phénomène du transfert*).

Several English colleagues have assisted at these metalloscopic experiments of Dr. Burq. They are well acquainted with them, and admit their reality, only some of them are inclined to believe that they constitute facts of expectant attention. As you know, if an observer concentrate his attention on any given spot of his body, and fancy that some subjective phenomenon must occur there, this is enough to produce a likelihood of the real occurrence of that phenomenon. If you think of an itching which may occur on any part of your arm, you will very likely feel a real itching on that part. Our *confrères*, therefore, think that the phenomena of sensibility which we observe in hysterical subjects during a metalloscopic application are facts of this kind. I do not think that their theory is applicable in this case; but the objections of distinguished observers

* Consult Dr. Tuke's valuable book, "The Influence of the Mind on the Body."

† The experiment was repeated at a late sitting of the Societe de Biologie, M. Bert, Professor of Physiology at the Faculty of Sciences, being present on the occasion.

must always be taken into consideration. It is not possible for me, at the present moment, to undertake a regular refutation of the explanation which has been proposed. I shall content myself with indicating a few arguments which seem to be opposed to their theory.

I shall instance, in the first place, patients in private practice who were seen for the first time, and who showed themselves, when subjected to these experiments, sensitive only to gold, others only to zinc, others again to copper, etc. It is difficult to suppose that they make a deliberate choice of a metal used, and I must add that at least the majority of them are naturally quite ignorant of all that concerns the effects of metalloscopic applications. But, among the facts opposed to the theory in question, none is perhaps more important and convincing than the transfer phenomenon. Let us take a patient affected with left hemi-anæsthesia, and completely sensible in her right side. You apply gold to the left arm, and you find that sensibility returns under the influence of the metal. Well, if you examine the sensibility in the portion of the right arm corresponding exactly and symmetrically with the spot of the left arm where you have applied the metal, and where sensibility has returned, you find that in this given spot you have developed complete insensibility. Thus, a sort of balancing, or of displacement of sensibility, has been produced; and this is certainly one of the most singular phenomena revealed by metallic applications. Such is the transfer phenomenon, which was discovered solely by chance, and which patients can neither invent nor simulate.

There is another phenomenon which you will soon witness on many patients I shall present to you, and which bears the same signification as the preceding one. It is a fact connected with hysterical amblyopia to which I called your attention in my last lecture. You know that in hysterical subjects there exists amblyopia on the same side where you find anæsthesia. One of the characters of this amblyopia is achromatopsy, or a narrowing of the field of vision in respect to colors. The narrowing may extend to such a point that the patient loses all notion of colors, and sees objects only with the appearance presented by a sepia painting. Moreover, this particular fact must be noted, that the colors disappear according to a mathematical order. Thus violet first disappears, then green, then red, then yellow. Blue is the last, and the patients continue to see it until the completion of the phenomenon, and when they have lost all notion of the other colors. This is a phenomenon, I should say, which an hysterical patient can scarcely guess or be acquainted with. It happened to myself, though I have for a long time been well acquainted with this phenomenon, to make a mistake in remembering the order of colors, which is, as you observe, different from the one presented by the spectrum. Here is an hysterical patient affected with hemi-anæsthesia and amblyopia of the left side. You remark that with the left eye she has lost all notion of colors. We know that this patient is sensitive to gold; we have proved it on a previous occasion. We apply a plate of metal to her left temple. A quarter of an hour is allowed to elapse. We now pass papers of different colors before the eye which is affected with achromatopsy. And now you see that the perception of colors is coming back according to the regular order. You see it is blue she first discerns, then yellow, then orange, next comes green, and violet is the last she perceives. You must watch narrowly in order to catch all the phases of the phenomenon, as sometimes the reappearance or return of sensibility to color, produced by the metallic application, takes place with great rapidity. As you see, this is a very demonstrative experiment which generally succeeds very well, and which we have repeatedly verified. I must, however, remark, that some patients present an exception to the rule in this sense, that the notion of red returns regularly to them before that of yellow and blue. But, as I say, this is really an exception; at any rate, it may be asserted that, according to the regular order, green, and especially violet, are the colors which return the last. If you now remove the plate of metal, you will find in a few moments that perception of colors will disappear in the following order—first violet disappears, then green, then red, then yellow; blue persists till the last; finally this also disappears, and the eye returns to the condition in which it was when the patient was presented to you.

Here is another hysterical woman who has been under treatment the last few weeks, and in whom all the symptoms of the disease—whether by the influence of the treatment or not, I do not know—have been remarkably amended. She has no longer any hemi-anæsthesia, and has lost all her convulsive fits for a long time. Is she completely cured? Has she ceased to be under the influence of the diathesis? Is she not exposed to a recurrence of her nervous ailments under the action of the first passing emotion? Some observations which we have recently made lead us to think that there exists perhaps a criterion for judging the question, and the fact, if we are not mistaken, is one of importance for the future of the patient. If you remember, this patient has proved sensitive to gold, and she has been treated, apparently successfully, with that metal. Well, we shall now apply some gold pieces to the left arm, this side of her body having been the one originally affected with anæsthesia. Fifteen or twenty minutes elapse after the application, and we then find that the patient complains of discomfort, that she gets drowsy, and presently seems ready to fall asleep. We prick her arm with a needle, and we see that sensibility, which was normal before the application, is now almost completely abolished. There is cause to believe that the patient is still under the influence of the diathesis, or, in other words, that she is not yet entirely cured.

I would remind you of what I have told you of the action of ether, which produces symptoms similar to those of an hysterical attack when the patient is still under the influence of the diathetic condition. "It seems," I said, "that ether is a reagent suitable to bring out the latent phenomena of hysteria." With metalloscopy, in the conditions I have described, you obtain a similar result. If, on the other hand, the patient is completely and permanently cured, she is no longer affected by the metallic applications to which she was sensitive before. This remarkable fact seems to result from our most recent observations, and it would form a sort of criterion, the importance of which will not be overlooked by practitioners.

I now present to you a young girl who does not belong to our wards, but who has been directed to us by Dr. Fieuzal, the well-known ophthalmologist, and who, after a set of common hysteric attacks, became affected, some four or five months ago, with hemi-anæsthesia and *ovarie* of the right side. She is affected with amblyopia, which, unlike what is observed in hysteric patients, is almost as marked in the left eye as in the right. Besides this weakness of sight, she had lost the power of distinguishing colors, so that she was unable to continue her calling as a mercer. Dr. Fieuzal had already found out that the application of plates of gold on the side affected with hemi-anæsthesia caused a return of sensibility, and he sent us the patient to have our advice touching the advisability of administering gold to her internally. We found that metal appropriate. She has now been taking it for a month, and at present the little patient is able to distinguish perfectly well all the colors. The anæsthesia which affected the right side, and the hysteric fits, have disappeared. This is certainly a remarkable result, and yet I do not consider her cure to be permanently established. We have had recourse to the criterion which you know, and on applying a string of gold pieces to the patient's forehead we found, after the lapse of a quarter of an hour, that numbness was produced, while the perception of colors disappeared successively according to the usual order, beginning with violet and ending with blue. We will now perform the same experiment before you, and we shall witness once more the disappearance of perception of colors in a determinate order, and the other fact that, when a patient is still under the influence of her diathesis, you can, by applying the same metal which formerly removed the disorder of sensibility, excite the recurrence of the morbid symptoms, and thus bring out the hidden diathesis.

We have now, I think, seen enough of metalloscopy, and it is time to pass on to metallo-therapy.

We have already stated that certain hysterical patients are sensitive to applications of gold, others to copper, iron, etc. These are facts which, I think, I am able to vouch for, and to which Dr. Dumontpallier, Dr. Luys, and myself bore witness before the Society of Biology. You have yourselves seen the greater number of them. They are, indeed, most interesting and curious. We have, up to this point, studied them in relation to the diagnosis of what Dr. Burq calls "metallic idiosyncrasy." Now we have to investigate the problem of metallo-therapy, or, in other words, the treatment of grave hysteria by metals. Here we have to deal with most serious difficulties, and here there exists a difference in the view entertained on the subject by Dr. Burq and myself.

I shall not dwell on external metallo-therapy, as Dr. Burq has, I believe, a tendency to place it second in importance to internal metallo-therapy. Besides, I have no personal experience of its value. Formerly, this was how Dr. Burq used to treat a case of hysteria: After having made out that the patient was sensitive to a given metal, he placed every day plates of this metal on different parts of the body, so that the patient resembled some knight of the middle ages covered with cuirasses and "brassards." People at the time amused themselves very much at the expense of this mode of treatment, and I really do not see why, as there even now exist other more singular modes of treatment which are not condemned in the same manner. Be it as it may, this metallic application had the effect of inducing at first a slight return of sensibility; but when the application of the metal was continued, this sensibility soon disappeared, and the morbid phenomena manifested themselves with increased intensity for a while. The patients complained of discomfort, numbness, and drowsiness in the cases to which I referred just now. Then, after a few days, it was noticed that the greater number of the permanent phenomena of hysteria became less intense, or even disappeared altogether. There was temporary cure, followed, after a certain time, by a recurrence of the symptoms. It was then necessary to begin again, and, after a certain number of times, a definite cure was at length obtained. The whole process might last altogether some five or six months. This was external metallo-therapy. As I have already said, I have no personal knowledge of this method, not having appled it myself, and not having had occasion to test its therapeutical effects.

And now as to internal metallo-therapy. Having practiced metalloscopy, and having determined the particular metal (gold, copper, zinc, iron, etc.) to which the patient is sensitive, metallo-therapy consists simply in administering the said metal internally to the patient. Most generally a soluble form is employed. Thus, with gold, we have made use of a solution of chloride of gold and sodium, containing one-fifth of a grain of the salt to twenty-five drops of liquid. It is a solution of a beautiful yellow color, transparent, with no bad taste, and which patients take very willingly. We administer ten drops before each meal in a quarter of a tumbler of distilled water. The doses are increased progressively, and we give no other remedy. If the patient has been found sensitive to copper, it is to acetate of copper in a solution with distilled water, and given in drops, that we have recourse; or else we employ the natural mineral water of St. Christau, which, as you know, contains copper. If sensitive to zinc, in like manner sulphate of zinc is administered; if to iron, one of the numerous preparations of that metal.

What is it that takes place after the administration of metals internally? When M. Burq spoke to me of internal metallo-therapy, and said that he cured diseases by giving metals internally, I simply said, "Perhaps so; we shall see." I like to keep aloof as much as possible both from the arbitrary skepticism which too often arises from pedantic ignorance, and from that *naïve* credulousness which characterizes the "charcoal-burner's faith," as the Germans sometimes say. It is between these two reefs, which are equally dangerous, that the observer must know how to steer. If any one came to me and said he cured cancer, without, of course, neglecting the use of caution, I should give him access to my wards in the Salpêtrière, where there are such a great number of unfortunate women laboring under that cruel affection. This is precisely the determination which I took in respect to M. Burq, when he affirmed that he held in his hands the efficacious treatment of hystero-epilepsy. I offered him the opportunity of proving the value of his method on four women, affected with this disease, who had been admitted into this establishment about ten years ago, whom I had shown a great number of times in my lectures, and whose pathological history was known to a great many very competent professional brethren. In a word, they were typical cases for a test, being affected with the gravest and most inveterate form of hystero-epilepsy. Out of these four patients M. Burq found three sensitive to gold and one to copper. To the three who were sensitive to gold we gave, following out strictly the previsions and desire of M. Burq, a solution of chloride of gold and sodium. To the one who was sensitive to copper we administered this metal, first in the form of oxide of copper in powder, and afterward in the form of eau de St. Christau. This took place in the month of July last. I was then busy with my lectures at the School of Medicine. The holidays then came, without my giving any particular attention to these patients, except for the purpose of ascertaining that they were taking their drugs and were not the worse for it. When I resumed my service in the month of October, I began to study them more closely, and I must declare that I felt, not surprised, as that would have been contrary to the declaration of principles which I made just now, but really moved to see that these four patients, whom I had selected myself as the most severe cases, were most remarkably benefited, to say the least. Must this result be put down to the credit of the treatment followed out? Is it merely a fortuitous coincidence? There in is a difficulty of appreciation which we often meet in the problems of therapeutics. I shall not otherwise occupy myself with the solving of the question. I shall content myself with placing all the facts before you, and you will judge for yourselves.

Among the four patients who will successively pass before your eyes three are extremely ameliorated, but must still, I think, be considered to be under the influence of the hysteric diathesis, as metallic applications have still the effect of producing in them the *ensemble* of symptoms to which I have called your attention, and which may be denominated *metallic anæsthesia;* I mean that, under the influence of applications of the particular metal which formerly restored temporary sensibility and muscular strength, these patients will become numb, drowsy, and insensible. As to the fourth patient, if it be true that we may, as I said before, take metallic anæsthesia as a criterion, she is to be considered as entirely cured. She was formerly sensitive to copper, and now, after having been successfully treated with sulphate of copper internally, she has entirely ceased to be sensitive to the application of plates of that metal, which formerly threw her into a marked condition of "metallic anæsthesia."

I shall now present these four patients to you, and we will repeat the principal experiments upon which is founded the doctrine of metalloscopy. Please remark the terms in which I express myself. I do not desire for the present to take any decisive part in respect to internal metallo-therapy. I do not judge it. I give you the means of judging for yourselves, by showing you the patients, and by indicating the circumstances under which they were treated. In order to affirm positively the efficaciousness of internal metallo-therapy, very many more experiments are necessary; but I cannot help declaring that, in my opinion, the facts observed are worthy of engaging the attention of medical men.

First, here is M——. It is she who, during her severe fits, would assume such extraordinary "passional" attitudes, and whom I have often employed for the purpose of showing the method of magic-lantern projections, which a great many of you have witnessed. She was affected with hemi-anæsthesia and *ovarie* of the left side. I have known her now for eleven years, and I assert that, during that protracted number of years, she never ceased to be hemi-anæsthetic and amyostbenic on the left side. I always took her as a type to show my pupils the hysteric phenomena on which I had insisted in my lectures. I used to run a long needle through her arm, to show what degree of anæsthesia she had attained, and never once did the experiment fail to prove her utter insensibility. Before her metallic treatment she was very thin; she scarcely ate, and had not menstruated for three years. She commenced to take gold in July, and, after a few days, she began to experience the effects generally produced by the internal administration of this medicine. The first effect is an increase of appetite, which becomes voracious. This in itself would be a very desirable result if it only lasted. But there soon supervenes a certain fatigue, a feeling of heat in the stomach, of itching in the skin, and restlessness. The best thing to do in these cases is to suspend the use of the drug temporarily, and to resume it after a time. In this patient the effect on menstruation and nutrition has been remarkable. The menses have returned and are now regular. She has gained flesh, and has even grown fat. Her fits have not disappeared completely, but have diminished in number and intensity. But the most striking phenomena is the disappearance of anæsthesia from the left side. The disappearance has been permanent for the last three months. It is true that it shows itself again in some degree after her attacks. But, whereas the anæsthesia was formerly constant, it now only returns at intervals and after the convulsive fits, and it does not last more than one or two days. She is still under treatment. The application of gold develops very rapidly, and in a marked degree, the phenomena of "metallic anæsthesia."

Here now is B——, who presents a less marked and less inveterate case of hysteria, but still one belonging to the order of hystero-epilepsy. She has been hemi-anæsthetic and subject to major attacks for three years. This patient was affected with right hemi-anæsthesia, and, at the same time, as is the rule, with right *ovarie*. She presented in a marked degree all the classic phases of the attack, epileptoid period, contortions, "passional" attitudes, final delirium. The patient was submitted to the internal use of copper in July last. Under its influence the anæsthesia and the fits have quite disappeared. The external applications of copper, which formerly threw the patient into that particular state which I have described to you, are now without any action on her. Is the cure complete, definitive? From all that precedes, I am inclined to think it is. Has it been produced by the action of copper? I leave it to you to decide.

Here is another patient sensitive to gold. I have known her to be hemi-anæsthetic in the left side for the last six years. As usual, she had left *ovarie*, and very marked hystero-epileptic fits. She was subjected to treatment with gold at the same date and in the same manner as our first patient. At present she has but very rare attacks. Hemi-anæsthesia never manifests itself but temporarily, for a few hours, and only after the attacks. The application of gold on the left side of the body causes a recurrence of what I call the phenomena of "metallic anæsthesia."

The patient I now show you is B——, in whom you have been able to study a most striking example of hysteric contracture. She has been diseased the last eleven years. She is affected with two distinct diseases, hystero-epilepsy (hysteria major) and real epilepsy. It is the combination which is usually called "hystero-epilepsy with distinct attacks." The internal administration of gold has produced no modification in her epilepsy. But it is not so with the symptoms of hystero-epilepsy. After the administration of gold, exhibited in the same manner as in the preceding cases, hemi-anæsthesia, which for the last eleven years had persisted, has disappeared, and the hystero-epileptic fits, which were very frequent and complete, have now become very rare. Yet they exist, and have survived anæsthesia, consequently the patient is still, in a somewhat marked degree, under the influence of the diathesis. The other day she had a fit, after which supervened contracture. But the contracture lasted only seven or eight days, whereas, before the treatment, it generally lasted one or two months. I will add that the anæsthesia, which formerly occupied the whole of the right side of the body, has shown itself after this attack only in the right lower limb, where the contracture had first developed itself.

These are the four patients that I had to show you. I leave these facts to your own appreciation. As to myself, I shall content myself with briefly drawing this conclusion, that the question is deserving of careful investigation.

Before concluding, I must state that you may meet with cases, though rarely, in which hysteric patients are not sensitive to any known metal. I must also add that, in the patients I have presented to you, and in whom a metallic idiosyncrasy has been found, the application of the suitable metal is without any effect when it is made at the time of the great attacks, or, if the word be used, of the hysteric tides. You must choose a period of calm, in order that the action of the metals may be brought out in full relief.

Such are the principal phenomena of metalloscopy and metallo-therapy which I wished to bring before you. I am desirous, however, to acquaint you with an episode which is not wholly irrelevant to the principal subject of this lecture, though it is not connected with hysteria.

Hysteric hemi-anæsthesia is not the only form of hemi-anæsthesia which may be modified by appropriate metallic applications, contrary to what Trousseau may have believed formerly, and to what Dr. Burq himself believed even quite recently. This has been shown by the results obtained in two of our patients affected with cerebral hemi-anæsthesia (I mean with involvement of the superior senses, vision and smell), consequent upon an organic lesion of the brain, which had produced simultaneously post-hemiplegic hemichorea. In those two patients the insensibility was absolute, and dated eleven years in one (R——), and in the other from her infancy, or about fifteen years (P——). A metallic application of iron in R——, and of gold in P——, has had the result of rapid and complete re-establishment of general and special sensibility. This result has not been altered for fifteen months, when the applications were commenced. I may just remark that in neither of these patients there exists the slightest trace of an hysteric diathesis. One is a woman of fifty-five, very calm, almost apathetic. The other is aged twenty-four, and is much more docile than the majority of patients of her age in my wards.

One word more before concluding. I wish to refer to the attempts made to elucidate the *physical* fact which must be the condition of the *physiological* action of metals. In the first place, M. Regnard has shown the important fact that extremely weak currents of electricity produce exactly the same effects as metallic applications. However, it would be, perhaps, inaccurate to draw the conclusion that metallic applications exert an action by determining currents. Such is the opinion of M. Romain Vigouroux, who has conducted a series of experiments upon the subject, and has deduced therefrom quite a regular theory of metallo-therapic phenomena. But I have no time to dwell longer upon a subject in connection with which, besides, nothing definite has been yet done.

SOME CAUSES OF MENTAL FAILURE.

WE have before us two suggestive documents which furnish data for consideration.

The first is the Fifteenth Biennial Report of the Trustees of the Illinois Central Hospital for the Insane; the second, a paper on Modern Life and Insanity, contributed by Mr. D. Hack Tuke to *Macmillan's Magazine*, which has attracted considerable attention from sociologists in England. The report covers the years 1875 and 1876, during which period 521 patients were admitted. Of these 226 were unmarried (160 males and 66 females) and 257 married (124 males and 133 females). The total number of men was 301 against 220 women. As to occupation 210, the plurality, are quoted as having simply domestic duties, and probably are all women; 149 were farmers, 57 laborers, and the remainder scattering through all the various callings. As to the exciting cause of insanity, this is reported as unknown in 280 cases, in 45 instances as owing to ill health, in 32 to female ailments, and so on scattering.

Mr. Tuke in his paper goes over a wide range of statistics, which it is unnecessary here to recapitulate, our object being chiefly to direct attention to the concordance of some of the data obtained in this Illinois asylum with those collated in England. And the first point to be noticed is the plurality of farmers over men of other occupations. There has already been much discussion as to the relative liability of manufacturing and agricultural districts to mental disease, and the general deduction appears to be that farmers and agricultural workers are afflicted in excess. The reason given for this by the Lunacy Commissioners of Scotland is significant. They refer, says Mr. Tuke, "the persistent rural lunacy chiefly to the constant migration of the strong from the rural to the urban districts, the necessary exodus of the physically and mentally healthy leaving behind an altogether disproportionate number of congenital idiots, imbeciles, and chronic insane in the agricultural counties." Even if in this country we are not disposed to admit that there is any so extensive an exodus from country to city as is here indicated—although the Governor of New York in his last message takes occasion to advise against this very movement and strongly to point out its disadvantages—yet there still appears, according to Mr. Tuke, a large amount of insanity and idiocy in country districts, whatever may be its relative proportion to that elsewhere.

From the Illinois asylum data it will also be observed that the number of single males is largely in excess of that of single females, but that the numbers of married people of both sexes closely approximate. Despite the increased responsibilities of family support upon the men, the proneness to insanity decreases, while on the other hand the domestic and physical troubles incident to wedlock more than double the percentage of women. This accords again with Mr. Tuke's statements of the large proportion of those engaged in domestic occupations in English asylums.

The percentage of intemperance noted in the Illinois report—15 out of 521—is exceedingly small. In Great Britain this cause unmistakably takes the lead, some authorities going so far as to attribute half of all the cases thereto. In the United States Dr. Rush has stated that it produces fully one-third of all the mental failures. Mr. Tuke places the percentage as low as 12, after taking into consideration all the asylums in England. Dr. Dickson, of St. Luke's Hospital, in London, has however pointed out that while intemperance is often an exciting cause to insanity, yet the incentive to drunkenness is the result rather than the cause of brain deterioration in the first instance. Regarded in this light, or rather if we consider, as is perhaps most logical, inebriety as a disease, and classify it with other ailments, it will probably appear—as indeed it does from the statistics of the asylum we are considering—that the road to insanity lies chiefly through ill health, and that those who lose their minds through other causes are much in the minority.

The brain, it would appear, is more apt gradually to follow physical deterioration than to be impaired suddenly by physical causes; or, in other words, as anything which will produce a hyperæmia of a portion or the whole of that organ by which its normal functions may be interfered with may become an exciting cause, that condition is perhaps more readily superinduced by the direct physical connection of the brain with other impaired organs.

Hence it follows that anything which debilitates the bodily constitution is liable to affect the mind, and hence, as might be expected, any form of intemperance, whether in drink, in mental or physical overwork, may react upon the brain as well as upon the rest of the system. If we knew how far this excess of strain might be carried before insanity became likely, a probable safeguard would be at hand, but this is not the case, and it is quite possible for a person to heap up predisposing causes up to a limit beyond which an accidental condition, in itself utterly incapable of affecting his normal unimpaired mind, may carry him.

The logical conclusion obviously is that upon the good health of the community depends its immunity from insanity. "Every man," says Mr. Tuke, "will break down at his weak point, be it what it may;" but clearly if his life be so ordered as not to continually carry him up to that weak point, the breaking down cause will have to be phenomenally great perhaps in the majority of cases to render it efficient. There is, therefore, such a thing as unpreventable lunacy, but preventable lunacy occurs most frequently, and this Mr. Tuke thinks, "may be reduced to a minimum by the widest extension of a thorough but not oppressive and too early commenced education, by the practical application of the ascertained truths of physiological and medical science, and by the influence of moral culture."

INCRUSTATIONS ON BRICK WALLS.

By WILLIAM TRAUTWINE.

THE disfiguration of brick house fronts by white incrustations is now so general, that it is to the interest of the public, and of brickmakers and builders particularly, that its causes shall be determined and a remedy applied, so that, if possible, houses built hereafter may be free from it. Many recent attempts at ornamental brickwork have resulted only in unsightly walls. The incrustation has been variously discussed in the newspapers, but owing to conflicting views of its causes, builders, brickmakers and bricklayers appear still to doubt the efficacy of any remedy hitherto proposed. It is desirable that all observed facts and statistics of attempted improvements should be collated and reviewed by some competent authority.

This defacement is most noticeable in dry weather on parts of walls subjected to dampness, and on entire walls after rain-storms have soaked them. North and east walls are coated on drying after northeast storms. Chimney walls and chimney tops, lines of leaky or obstructed water-spouts, spaces beneath window-sills, walls near the pavement, and pavement bricks, are especially marked. The white coating is derived primarily from both bricks and mortar, and in some cases it is difficult to decide, without dissecting the walls, whether the bricks, the mortar, or both, are or are not concerned. The Bankers' and Brokers' building, opposite the Stock Exchange, is not yet completed, but its walls are already unsightly with white patches. The black mortar or cement with which they are pointed has disintegrated and crumbled out here and there, leading to the conclusion that this is chargeable with the defacement. The bricks, however, are coated where the pointing is not at all affected, and one particular brick, which was left out of the wall, and was faultless in form, color and consistency, showed white patches when it dried after having been wet.

It will be found most convenient to consider, first, the incrustation as derived originally from the bricks. It is most conspicuous on comparatively new walls. It may be observed in the outskirts of the city, on very new walls of unfinished houses in which no fires have burned, and where the mortar is unchanged. In these cases the white substance is dissolved by moisture from the bricks, which contain it before they are built into the houses. The writer has visited several brick-yards in the suburbs, where piles of new bricks, which had never been in contact with mortar, but remained in a comparatively pure atmosphere since leaving the kilns, showed the common white incrustation. Some of the bricks which remained in the kiln were also coated. In several yards the incrustation had, here and there, a yellow tinge, possibly from traces of oxide of iron or hyposulphite of lime. One of these bricks, taken hap-hazard, was examined somewhat in detail. The white coating had a peculiar taste, in which that of sulphate of magnesia (Epsom salts), though disguised, was recognizable. As this white substance had come out from within the brick, the latter was crushed and the debris digested in water. At the end of a week the water had dissolved out a mixture, consisting mainly of the sulphates of magnesia, lime, and iron. This brick contained no traces of sulphites, soluble carbonates, or soluble chlorides. The white incrustation disfiguring several fine pressed bricks in a new wall was also examined. It had so saline a taste that most persons would have pronounced it common salt. Nevertheless it contained none. It was almost wholly sulphate of lime and magnesia, with traces of iron and alumina. No carbonates were present. Several other specimens of incrustation were examined, with the same results. Two specimens of incrustation were examined specially for soda and potassa, but neither contained noticeable quantities.

The fact being established that bricks burned with coal fires are impregnated with the soluble sulphates mentioned above, specimens of brick clay from the pits of different brick-yards were next examined, in order to determine whether, and to what extent, these salts originally exist in brick clay, or are produced when bricks are burned with coal fires. None of the specimens contained free sulphuric acid or appreciable quantities of soluble sulphates (such as the sulphates of magnesia, lime, or alumina). They contained no soluble carbonate or chloride. Only minute quantities of insoluble carbonates (such as the carbonates of lime and magnesia) were present. Further examination proved that all the specimens consisted chiefly of clay proper, *i. e.*, silicate of alumina, with much oxide of iron, and small proportions of lime and magnesia, which, presumably, were also contained as silicates. The proportions of lime and magnesia contained in the clay—separated by long digestion with an excess of hot sulphuric acid—about equaled those existing as sulphates in the aqueous brick solution; suggesting the inference that brick burning may, in some instances, convert all, or nearly all, the supposed silicates of magnesia and lime into sulphates.

The process of burning bricks with coal sufficiently accounts for this conversion. Nearly all coal contains diffused particles of sulphide of iron, or iron pyrites. These are decomposed when coal burns, and sulphurous acid gas is one of the products of the combustion. When sulphurous acid gas, air, moisture, and substances which have an affinity for sulphuric acid, are brought together at high temperatures, long sustained, sulphates of the susceptible substances are formed. The silicates of lime and magnesia are probably decomposed under these circumstances, sulphates of lime and magnesia being formed, while silica is liberated. It is, therefore, reasonable to suppose that when the dense, sulphurous vapors of a coal-burned brick kiln, which are suffocating outside of it, are diffused, with moisture and air around and through the clay of intensely heated bricks for the greater part of a week, the fires being maintained usually three days, and the kilns opened at the end of a week, a reaction takes place, and that when the bricks are turned out from the kiln, they are impregnated with the above-named sulphates. When the bricks become wet, these compounds dissolve, and in dry weather, succeeding storms, the solution, evaporating from the surface of the bricks, leaves them coated with these white compounds.

Sulphate of magnesia possesses the peculiar property of efflorescing, or blossoming, in dry air. In this way a very small amount becomes conspicuous. Brick clays contain varying proportions of lime and magnesia, and the percentage of iron pyrites varies in different specimens of coal. Bricks may be noticed apparently overstocked with the sulphates of magnesia and lime. These are much whiter in dry weather than others surrounding them. Coal is now generally, if not universally, used here for brick burning in place of wood. Coal dust is commonly mixed with brick clay in clay pits, and may add to the production of sulphates within the bricks. The white incrustation, however, occurs on bricks in yards where coal dust is not mixed with the clay. It is not used in pressed bricks, and these are as frequently defaced as others. Common bricks, in back buildings, are coated with the white incrustation, but generally escape attention. Bricks least subjected to sulphurous vapors while burning, may be less impregnated with the sulphates of magnesia, etc., than others.

The simplest way to get rid of the sulphates, so far as the bricks supply them, is to avoid producing them while manufacturing the bricks. Pressed bricks and others intended for ornamental purposes might be burned with wood or with coke, if free from sulphur, in separate kilns far away from places where coal is burned in considerable quantities. Unless afterward exposed to an unusual amount of sulphurous vapor, they would probably undergo no change.*

It has been asserted that the white coating was formerly noticed on bricks burned with wood, but the evidence appears to be mostly the other way. It is quite possible, though, that a white efflorescence, derived from the mortar, may have been observed on old wood-burned bricks, or that such bricks in rare instances have been specially subjected to sulphurous vapors, and thus altered.

It has been suggested that the white incrustation results from chemical change effected in bricks by sulphuric acid vapors in the air, derived from coal burned as fuel, and from the combustion of illuminating gas. If the gas is properly purified at the gas works, little sulphuric acid can be traced to it. Much more is generated by burning coal in houses and factories, but it is at least doubtful if much change is effected by it in bricks, particularly after its diffusion, though there is no doubt of its effect, in time, upon mortar, as explained hereafter. We have seen that bricks now generally contain enough of the unwelcome sulphates before they are placed in walls, and that, in some instances, all the susceptible magnesia and lime in them are then already converted into sulphates. The small amount of sulphuric acid diffused in the air is insufficient to produce any effect until after long exposure, yet new bricks are more disfigured than old ones. Silicates of lime and magnesia in the semi-vitrified bricks are somewhat protected from the action of the air. It is questionable, on the principle of elective chemical affinity, whether these silicates, even if more exposed, would undergo decomposition in the presence of the more vulnerable mortar. Some bricks, however, may contain free lime and magnesia.† If the atmospheric acid vapors affected silicate of magnesia in bricks, serpentine stone fronts—almost wholly silicate of magnesia—would be much more affected. Many of these have been carefully examined, but in no case were the stones altered. Sometimes, the thick lines of mortar between them being decomposed, solution of sulphates from these had washed over the stone-work and defaced it.

Sulphate of magnesia is largely produced by the decomposition of mortar. Most of the lime used here is burnt from magnesian limestone obtained in this vicinity, and the result is a mixture of lime and magnesia in varying proportions. The limestone belt of Chester Valley, which runs diagonally across the State, and which furnishes most of our lime, is largely magnesian limestone, the lower subdivision of the same formation in New Jersey being specially named the magnesian limestone in New Jersey geological reports. The mixture of lime and magnesia thus obtained, when slaked and made into mortar, is very susceptible to the influence of sulphurous fumes. These react, forming the sulphates of lime and magnesia. The great solubility of sulphate of magnesia facilitates its diffusion, and makes it the chief cause of defacement, sulphate of lime being comparatively insoluble. As the sulphate of magnesia dissolves and effloresces, the mortar is disintegrated. Sulphurous acid, from coal burned in houses, produces its chief effects before it is diffused in the outer air. As it passes up through a chimney it finds its way through crevices and pores in the wall, and thus directly attacks the mortar; sometimes causing the fall of chimneys, by eating out the mortar cementing them. The bricks, when damp, absorb sulphate of magnesia, or sulphate of magnesia and lime, from the altered mortar surrounding them. Sulphate of magnesia from altered mortar is most noticeable within doors, on chimney walls and in cellars, where the damp mortar is directly subjected to sulphurous vapors. Efflorescent crystalline masses of sulphate of magnesia often accumulate and protrude from between the loosening bricks.

Dampness produces a solution which is sometimes diffused through a brick and makes its appearance outside, while the outer lines of mortar bordering the brick remain intact.‡ Several soft bricks in the outer wall of a chimney flue were examined recently. They were completely impregnated, as well as coated, with a white substance, which had disintegrated some of them, and which, on analysis, proved to be sulphate of magnesia, with traces of lime, alu-

* Clay sometimes contains iron pyrites, and its decomposition results in the formation of sulphates. Such clay, is, of course, unsuitable for bricks intended for house fronts.

† The writer does not assert that the magnesia and lime found by him in the clay specimens existed as silicates. This point was not determined, and is assumed only because no carbonates or sulphates of magnesia or lime were found in the clay.

‡ Bricks readily absorb solutions such as those of common salt, soap, etc., and these substances appear on the surface when the solutions evaporate.

mina, and oxide of iron. Sometimes, after long exposure, the outer lines of mortar appear to be directly affected by sulphuric acid vapors diffused in the surrounding atmosphere. Delicate crystals and protuberances of sulphate of magnesia, and washings from these, were observed on mortar lines in brick and granite garden walls, as well as on house fronts. Thick mortar lines in walls of brown stone buildings are much affected. Churches at Thirty-sixth and Chestnut streets, Eighteenth and Columbia avenue, and Franklin street, near Brown, will serve as illustrations. The Syenite retaining walls inclosing the Friends' Meeting House, at Seventeenth street and Girard avenue, and those of the House of Refuge, on Poplar street, show the defacement. In all these cases—particularly in the instances of the Syenite walls—sulphuric acid vapors clearly do not affect anything within the stones. In some cases mortar contains the sulphates of lime and magnesia before it is used. Most of our lime is burned with coal, and a half dozen specimens of quicklime from different lime-kilns yielded slight traces of the sulphates of lime and magnesia. If we accept the development of these traces of sulphates in the lime by coal burning, mortar is probably made and used now about as it has been for many years past, excepting also that mud is sometimes used in place of mortar. Much more sulphuric acid, however, is now generated within the city limits, particularly in winter, by the greatly increased use of coal.*

To avoid this white defacement developed from mortar, builders should use lime free from magnesia in erecting exposed brick-work. A demand for such lime will bring ample supplies from other localities, and at low prices.

Continuous exposure to sulphurous vapors may effect some change even in mortar made from lime containing no magnesia But, as before stated, the great solubility of sulphate of magnesia, and its tendency to effloresce, make it the chief evil, and it is worth while to try the result of using purer lime.

When argillaceous limestone is burned, hydraulic cement is formed. The resulting mixture of lime and burned clay (usually with some sand), when wet, "sets" compactly, and the admixture of clay may, to some extent, protect the lime from such influences as might otherwise affect it injuriously. Portland (hydraulic) cement is made by burning an artificial mixture of limestone (chalk) and clay. Portland cement is believed to contain but a small proportion of magnesia, and this circumstance, in connection with that of the possible protective influence of the clay, justifies the supposition that walls built with this cement may show less white defacement than those in which our ordinary mortar is used. Several brown-stone base-walls, laid in good cement, and particularly exposed to dampness, were examined, but showed no defacement. The painted walls of a room in the building of one of the trust companies in this city lately became much disfigured by the formation of efflorescent crusts of sulphate of magnesia and lime, from the decomposition of mortar within the walls. At the writer's suggestion, hydraulic cement was substituted for the mortar, and the walls repainted. This has since remained unaffected. Cements vary in price and quality, from good to worthless.† Chimneys might be laid in cement, and if white markings between the bricks are desired, these can be painted or pointed with marble dust. This is nearly pure carbonate of lime, and is used in mortar for pointing. It appears to remain a long while unaffected, indicating that sulphuric acid vapors in the air exert little influence upon it. Plaster (sulphate of lime) is not generally used for pointing. Unless largely mixed with mortar it would crack off or be dissolved, and washed by rain over the bricks. Paint serves to some extent as a protection from dampness. The disfigurement may, however, be observed occasionally on painted brick walls after damp weather, the paint being discolored, and in some cases thrown off by the incrustation forming beneath it.

The unsightliness caused by the white incrustations is intensified by contrast with what may be termed the black streaks. On almost every brick house these hang repulsively at either end of each window-sill. They represent the repeated washings of dust and dirt from window spaces and window frames. Scrubbing brushes, vigorously applied, might remove them. Any simple device would serve to divert the dirty drippings which soak the bricks beneath the windows, developing characteristic white patches here between the black streaks. As it is, the model Philadelphia brick house, with its white incrustations and black streaks, is a reproach and shame Builders and brick manufacturers who prevent these evils in new houses may reasonably expect to reap public gratitude, and, perhaps, something more satisfying. Entire blocks of houses have so changed countenance, have "so gone down," within a single year, as to repel desirable tenants, when, indeed, they remained in all other respects unchanged. The subject under consideration has for a long time interested the writer from a utilitarian standpoint, rather than a scientific one.—*Journal Franklin Institute.*

THE WHITE INCRUSTATION ON THE BRICKS OF CITY HOUSES.

AT a recent conversational meeting of the Philadelphia County Medical Society, Dr. Henry H. Smith, President of the society, in the chair, the rules were suspended to receive the following report by Joseph G. Richardson, M.D., Professor of Hygiene in the University of Pennsylvania, from the Committee on Hygiene:

The sub-committee appointed to examine the incrustation so abundant upon the east walls of brick houses in Philadelphia, and to consider its probable effect upon the public health and possible association with the prevailing epidemics of diphtheria, scarlet fever, typhoid fever, etc., respectfully reports—

That a quantity of the grayish white powder being collected by scraping, it was found, on examination under the microscope, with a power of two hundred diameters, to be chiefly composed of small acicular and prismatic crystals with dihedral summits, which, on the addition of water, were seen to dissolve with great rapidity, leaving a few granules and an occasional angular particle.

In order to obtain a larger quantity of the insoluble matter for investigation, two grammes (thirty-one grains) were agitated with twenty cubic centimeters of water, and after standing twelve hours a drop of the reddish-brown deposit let fall was examined microscopically as before. It was found to be made up of, first, particles of brick and of quartz, etc. (sand); second, portions of coniferous wood, leaves, stellate hairs, and other *débris* from the vegetable kingdom; third, fragments of cotton, flax, and dyed wool, evidently derived from clothing; last, but not least, cells of pavement epithelium, singly and in groups of eight or ten. These were probably human epithelial cells, rubbed off from the skins of the thousands of passers-by in the street below, and carried by the wind, as dust, to the fourth story of the house from the front of which I scraped them. Of course, had they proceeded from the cuticle of any person suffering or recovering from small-pox, scarlet fever, syphilis, etc., they might, under favorable circumstances, have conveyed these diseases to any individual upon whom they happened to alight. No bacteria, bacteridia, microthrix, or leptothrix filaments were visible, although their germs were doubtless present.

In order to determine the exact constitution of the crystals the solution was carefully filtered off from the insoluble portion, which latter, after desiccation, was found to weigh twelve centigrammes (about six per cent.) of the whole; and after some preliminary experiments the trace of iron was removed by precipitation with ammonic sulphide, and the decanted fluid treated with hydric-disodic phosphate, which threw down a bulky white precipitate of magnesic phosphate. The combined acid was shown, by testing with baric chloride, to be sulphuric, and since the precipitate of magnesic phosphate obtained was equal to that derived by a similar process from one and three-quarters of a gramme of magnesic sulphate, this incrustation upon our brick walls is thus proved to be largely, if not chiefly, composed of the common sulphate of magnesia, vulgarly called Epsom salts.

The probable mode of formation of this saline exanthem is, it seems to me, that the sulphuric acid from our million of gas burners and coal stoves is absorbed by moisture deposited during the evening upon the front walls of houses facing the east (and therefore shaded from the afternoon sun). The extremely dilute acid coating thus produced then combines with magnesia contained in the bricks, or possibly in the mortar, and, when its water is evaporated by the morning sun in dry weather, crystallizes in the unsightly incrustation now lamented by so many property owners of our city.

The evil may doubtless be palliated by thoroughly washing and scrubbing the affected walls, but by way of prevention it might be worth while to try subjecting the bricks to a sulphuric acid bath, followed by prolonged immersion in running water before they are built into a house front. A thick coat of paint would probably effect a cure.

In view of the circumstance that no fungous or fungoid growths are discoverable in the deposit, and also that our water supply is derived from sources in great measure inaccessible to the washings of house walls, I think we may conclude that this white incrustation has no injurious effect upon the health of the inhabitants of Philadelphia. On the contrary, since its presence is an evidence of the fixation of a deleterious product from coal and gas combustion, we may even look upon magnesia in this form as an important aid toward securing for our citizens that great desideratum of sanitary science, pure air.

* Rain absorbs acid vapors contained in the air through which it falls, and driving rains from the northeast may thus acidify, as well as moisten, north and east walls.

† White efflorescences, chiefly of the carbonates of soda and potassa, sometimes disfigure walls built with cement mortar. Rosendale cements frequently contain a large percentage of magnesia, together with soda and potassa. (*Vide* Gillmore on Limes, Hydraulic Cements, and Mortars, N. Y., 1868.)

CHARACTER OF THE SOIL INDICATED BY ITS NATURAL FLORA.

BY G. S. BOULGER.

THOUGH no value can be attached to advertisements of grasses of species selected as suitable to each soil according to its geological age, since the most astute botanist would be puzzled to differentiate an Oxford clay flora from one collected on clay of Kimmeridge or Wealden age, yet it is only necessary to make a general reference, at present, to the papers of Professor Buckman, Mr. Bravender, and others, in the *Journal* of the Royal Agricultural Society, as evidence of the relation between the chemical and physical character of soils and the prevalence of various species of grasses. "In the North of England," writes Mr. J. G. Baker, "we have masses of dry rocks of calcareous constitution, with great belts interspersed between them of strata of other kinds. There are in the North Riding of Yorkshire 67 species, or one in 13, of the indigenous plants which follow the dry rock from area to area, and avoid the intermediate belts, more or less decidedly. I may mention the Columbine, Lily of the Valley, Fly Orchis, Bee Orchis, Helianthemum vulgare, Geraniums anguineum." This brings us to the botanical side of M. Thurmann's classification of soils, before mentioned, which is critically summarized in Messrs. Trimen and Dyer's invaluable Flora of Middlesex. It is mainly based on the floras of the two great mountain ranges, the Vosges and the Jura. The former is granitic, and therefore produces clays and sands of a moist character, while the latter consists of oolitic limestones producing dry soils. In the British flora the damp-lovers of the former class of soils predominate. *Sand Plants.*—M. Thurmann classes as sand-lovers Galium saxatile, Jasione montana, Phragmites communis, Ulex europæus, Sarothamnus scoparius, Ononis spinosa, Saxifraga granulata, Scandix pecten, Digitalis purpurea, Antirrhinum Orontium, Betula alba, Osmunda regalis, and others; and to these, for Middlesex, Viola canina, Ulex nanus, and others, have been added. Jasione montana occurs on the chalk, and Ulex europæus, though shunning lime, grows on clay as well as on sand or gravel. Ononis spinosa and Viola canina flourish on the oolitic stone-brash and on leaf-mould, while Scandix and Antirrhinum Orontium grow in loamy fields in Surrey and Berks. I have never seen the Foxglove on limestone, it being most luxuriant on the Hythe beds of the Lower Greensand. *Clay Plants.*—Among clay-lovers M. Thurmann mentions Stellaria Holostea, Lysimachia nemorum, Alisma Plantago, Alnus glutinosa, Tussilago Farfara, Specularia hybrida, and Chlore perfoliata, the last three of which I have seen flourishing on almost bare chalk. For Middlesex, Genista tinctoria, Sanicula europæa, Viburnum Opulus, Primula vulgaris, Orchis Morio, Fritillaria Meleagris, and Ophioglossum vulgata are justly added. *Lime Plants.*—Among the dry-lovers, or lime-lovers, are Orchis pyramidalis, Daphne Laureola, Fagus sylvatica and Rosa rubiginosa, Gymnadenia conopsea, Ophrys apifera and Ophrys muscifera, Ruscus aculeatus, Ceterach officinarum, Scolopendrium vulgare, which are of this character both with us and on the Continent; while in England we should class Specularia, Chlora and Neottia Nidus-avis with these. The latter grows in the leaf-mould around Beeches, which is often deep; Scolopendrium flourishes in loam, and Ophrys apifera occurs on some of the more calcareous clays of the Lias. But while M. Thurmann's essay shows the vast importance of the physical characters of the soil on the distribution of plants, it seems also to show some of the weight of chemical character. For would not many of the dry-lovers frequent sands as well as limestone were they not lime-lovers, and would not many clay-lovers occur on the thin clays of the limestone rocks were they not lime-shunners? Geological age will sometimes, though not always, indicate chemical as well as physical character; thus, if the fertility of the Atherfield clay be wholly due to its physical characters, that of the Upper Greensand is certainly not, for, if so, the Lower Greensand or Bagshot beds should be equally productive. It is also important for gardeners to distinguish between the sites in which a plant will grow and those in which it grows by choice. Take the Cowslip as a single instance. It grows, flowers, and seeds on chalk downs and upland oolite brashes, but the specimens on these soils cannot be compared to the giants of the Gault and Lias clays. Geology cannot, perhaps, be held out as an essential study for the gardener, but if it be admitted that his aim should be to make plants at home by close imitation of their natural condition, this sketch may, it is hoped, show its value as an auxiliary study. One very important field of observation lies open to gardeners. I allude to the investigation of the quantity, and especially the quality, of fruits of the same variety grown on different soils. This is a matter on which the readers of the *Gardeners' Chronicle* would be thankful to receive trustworthy information. It only remains for me to express my great indebtedness to Professor Buckman's *Stone Steps*, Mr. Topley's *Geology of the Weald*, and Mr. H. B. Woodward's *Geology of England and Wales.*

IMPROVED COW STABLES.

By J. WILKINSON, Harvard, Ill.

I WAS not a little amused by an article in your issue of January 5th, headed "LABOR-SAVING COWS."*

The article is illustrated—three cows are shown in a standing attitude, in stalls.

A timber is rigidly suspended in a horizontal position over and near the backs of the cows, the claimed purpose of which is to cause the animals to step to the rear when they desired to void alvine discharges. The inventor had discovered that the animals raised the back when they evacuated, and the timber prevented that and caused them to step backward until the timber was over the shoulders, which caused the droppings to fall into a gutter placed well to the rear, leaving the floor space between the gutter and the manger cleanly.

It is not my purpose to condemn or approve the arrangement, but simply to prove by the adoption and use of this device that dairymen consider some means of securing greater cleanliness than is practicable with the ordinary arrangement of cow stables desirable.

I recently read in an agricultural journal a description of another device for the same purpose. It recommended to remove the entire brush of the tails, and thus avoid their becoming saturated with urine while lying in the gutter in the rear of the file of animals, which is common while they are in a lying position; in fact it is unavoidable with the ordinary manure gutter arrangement.

No quality, or quantity, practicable, of bedding or absorbents in the stable will insure immunity from the intolerable filthiness resulting from this defect in cattle stables, yet one sees in almost every article on stable management a strong recommendation of the use of absorbents in stables.

As ordinarily used in common stables, bedding and absorbents only increase the evil, and render the bed more uncomfortable and the air of the stable more fetid. I know of no greater error, greater barbarity, or more unmistakable evidence of ignorance of stable economy, than the use of a stable as a stercorary. To an intelligent live stock manager the idea is really revolting, so flippantly and perpetually paraded by would-be teachers, that the stable should be strewed with a variety of absorbents, *e. g.*, straw, long and short, leaves, sawdust, spent tan-bark, muck, etc., with which to absorb the liquid excrement and hold it in the beds of the pitiable imprisoned animals.

A few minutes' experience for these blind guides of the blind, with their noses on the same level as those of the poor brutes which they compel to lie on a bed of filth, such as any of the absorbents named, when saturated with urine, supplies, would probably satisfy them that, after all said, these claimed stable purifiers do not prevent an intolerable degree of impurity in the air of the stable, when the fetid eliminations are augmented by animal heat.

During the period of twenty years or more have I, as often as once a year, ay, and more frequently than that, published in various agricultural journals severe denunciations of the practices described, and as often recommended a practicable and effective way of keeping the stable pure and cleanly.

In my system, I dispense with all bedding and absorbents, provide for precipitating both the solid and liquid excrement through an open floor; immediately conduct the latter out of the stable entirely, usually depositing it in a cistern for the purpose—the solid mainly falls through the open floor into a concealed gutter, and what does not is trodden through the openings in the floor. The gutter is spacious and accessible, and in the use of sub-earth ventilation the comparatively dry excrement lying in the gutter beneath the floor is soon cooled, and the surface of it dried, so that all elimination of fetid odors ceases. With this arrangement it has proved, after twelve years' experience with it, that a clean, dry, latticed stable floor, the head portion of it of wood and the rear of iron, in a non-freezing stable, is infinitely more cleanly, comfortable and healthful than a stable with a close floor, exposed surface manure gutter, and any amount of bedding and absorbents.

In the use of sub-earth ventilation in the cattle stable, it is found that the dry air admitted from the underground duct maintains a temperature of 50° to 55°, which so cools and dries the excrement that, if it should be necessary to defer the usual daily cleansing of the manure gutters for a week, the contents could neither be seen nor smelt, and contact with it by the animals is impossible. I have now in process of erection, in Iowa, a suite of dairy farm buildings, for which I furnished plans, etc., in which subterranean ventilation is used on a grander scale than I have ever used it hitherto. A stable for 124 cows, a milk house, three dwellings, a colossal root cellar and an engine room are all to be tempered and ventilated by the same sub-earth air duct. The duct is three and a half feet in width, six and a half feet in height in transverse section, and 450 feet in length. It is tunneled into a hill, and is an average of 20 feet below the surface of the ground.

There is also a large hog house some 400 feet distant from the other buildings described, which is ventilated in the same manner.

This suite of buildings is designed to be as near perfection as possible, and to excel all others for the same purposes in the world.

* "Scientific Farmer," SUPPLEMENT, page 1674—No. 105.

BEET-SUGAR MANUFACTURE.

OUR European correspondent on agricultural matters, and especially on the subject of beet sugar, has returned from Germany, bringing with him a complete model of an improved sugar factory, which seems destined to solve the problem of the successful manufacture of beet sugar in this country. The main features in this entirely novel construction are the combination of great working capacity with simplicity in the details, in order to avoid the enormous outlay required to erect sugar factories as now constructed in Europe. The erection of the whole beet-sugar factory and eight drying kilns, with a daily capacity of 150,000 pounds of fresh beets, producing 15,000 pounds of raw sugar, is estimated to cost but $25,000. With this moderate outlay the factory, with continuous work, will be able to produce easily over 2,500,000 pounds of sugar per year.

This new design for a sugar factory consists of three parts: First, a kiln for drying the green or fresh beet, after it has been sliced by an ordinary root cutter, on the same principle as that used in drying peaches, apples, or other fruit. An important feature in this dry-kiln is the use of a hot-air blast, where any kind of fuel can be used for heating the air, without damaging the peculiar sweet taste of the beet. One of these dry-kilns could be erected at a cost of $1,000, and, being simple in construction, could be easily managed in any section, and has a drying capacity of twenty tons per day of beets. The beets so dried are about one-half pure sugar, with the woody fiber impurities and ten per cent. of moisture mixed. In this form the beets can be kept in good state for any number of years.

These drying-kilns may be erected in any locality around which the neighboring farmers will contract to supply given quantities of beets. In drying, five tons of fresh beets may be reduced in weight to one ton of dried beets, which will facilitate their cheap transportation to a sugar factory, and thus give such an establishment the benefit of a continuous supply of beets. Again, by this method the farmer is enabled to haul his crop of beets direct from the field to the drying-kiln, thus disposing of the question of storage by pitting or otherwise, and also saving the expense consequent upon extra carting and hauling.

The second part of this new beet-sugar factory consists of the battery for extracting the sugar by means of water. For this purpose twelve vats 3½ feet in diameter by 7 feet in height are arranged like a terrace, so that the sugary matter flows from one into the other. When it has passed through them all a gallon of it contains about five pounds of sugar and has a specific gravity of twenty-five per cent. Baumé. These vats are made simply of wood, yet inside is another made of sheet iron, provided with a perforated bottom and a similar top which is movable. These sheet-iron vats can be taken out of the wooden ones by means of a pulley, by which they are also put in when filled with new beets. This battery is entirely new in all its features, exceedingly simple in its operations, and very effective in its practical workings.

An apparatus for concentrating the beet juice to the point of crystallization is the third part of this beet-sugar factory. This latter much resembles the method used in sugar plantations in the tropics, though combining practical and important improvements, that have been suggested by experience and practical investigation. One thing is certain: if beet-sugar manufactories, even for producing raw sugar, can be successfully established at a cost not exceeding $25,000 each, a new branch of farm economy will be opened up to the farmers of this country that will enable them to produce a cash crop, and at the same time retain in the United States part of the $80,000,000 to $100,000,000 in gold now spent in the purchase of sugars of foreign production. We wish the new enterprise all the success which it merits. The agriculture of the country would be much benefited by the practical introduction of the beet-sugar industry.—*Boston Cultivator.*

THE CARE OF HORSES.

AT a late meeting of the Croydon Farmers' Club, a lecture was delivered by Professor Pritchard, of the Royal Veterinary College. The first question he would ask was, Are horses better in boxes or in stables? Provided they had plenty of room he held that nothing could be better than a good loose box, in which the horse has an opportunity of moving about, and thus getting beneficial exercise. A loose box should be of a good height, and at least 10 feet long by 6 wide. He would recommend a length of 14 feet and a width of 12 feet. He recommended the use of stone for the structure, if it could be obtained, with foundations of concrete, or with slate between the first few courses, if built of brick. He also recommended the lining of walls with wood inside, elm being the best. He sometimes found glazed tiles used, but these, if used in a light stable, should never be white, the glare being liable to affect the horse's vision injuriously. Where room was not of excessive importance, he was opposed to having either lofts or sleeping-rooms over stables. He would have the roof ceiled on the inner surface, or, still better, would have a thatched roof, the only objection to which is that it is more liable to fire. As to the flooring, it must be of such a nature as not to absorb moisture nor to be slippery. He had seen nothing better than ordinary bricks carefully laid edgeways, care being taken to select good bricks. These will never become slippery nor absorb any great amount of urine. There should be an ingress of fresh air and egress of the air poisoned by the breathing of the horses. This must be secured without draught, and to do this there were some very elaborate contrivances, but his own experience taught him that they were unnecessary, ingress openings being provided near the ground, and egress openings near the roof. With regard to drainage, he would simply lay a [surface?] iron or stone with a groove by which the largest stable might be properly drained. With regard to temperature, he would, if possible, keep it as near as possible to 56° or 60° Fahr. all the year round. He then came to the subject of lighting. A horse kept in a dark place would show a better action on being brought from his stable into the air, and he believed it was a fact that horses so kept would look better in their coats. He recommended that iron mangers should be fixed in brickwork, for he had seen several cases where the horse had reared, put his feet in the manger, and broke it right through. He strongly objected to the unnatural practice of fixing racks above the horse's head. He recommended the use of ordinary head collars. He advised that food should be given in small quantities and frequently, the horse's stomach being small in proportion to the size of the animal, and in consequence of the mode of digestion in the horse's stomach he was quite certain that it was best to give the horse his water to drink before his food. An opposite course of procedure frequently leads to attacks of colic, and gives rise to pain and inconvenience. He attributed this to the gastric juice which ought to digest the food becoming diluted by the admission of water into the stomach while the food is there. He did not believe the horse preferred dirty to clean water, but that he prefers soft water to hard to such an extent that he would rather drink dirty soft water than clean hard water. He approved of putting a little warm water into that drunk by the horse, rather than the practice of some grooms of putting the water in the warm stable for the night to have it a little warm in the morning. As to the quantity of water to be given, he recommended, under ordinary circumstances, that the horse should have as much as he wants, making exceptions in cases where the horse was to be put to violent exercise in a short time. He objected to the practice of always keeping the water in front of the horse. On the subject of feeding, he recommended the best food, and regularity in feeding. Ordinary horses should be fed three times a day. A little hay should be given to the horse to amuse himself with during the cleaning out of the stable, and he should then have his water offered to him, but he would certainly not allow him to have anything like a meal before giving him the water. He would have about a peck of corn, with a small quantity of cut hay and a little bran, divided into three or at most four feeds for the day. As to bedding, nothing could be better than straw, which should be thick in those places where the animal might injure his houghs. In case of a horse having a habit of much pawing, sawdust might be used in front of him; indeed, sawdust might be used generally, but not in those stables which have underground drainage. He would impress on his hearers the fact that horses must be groomed to keep them healthy, as well as to make them look well. With regard to grooming horses' legs, he believed that with care in this particular there need not be fever or cracked heels to the extent now found. Instead of bringing the horse in when coated with mud, and sluicing him with cold water, or even tepid water, he would have the mud wiped or scraped off as far as practicable, and then the legs wrapped round till they dried. He believed hundreds and thousands of cases of mud fever might be prevented if this plan were used instead of the system of throwing water over them or excessive washing. He should only speak of bandages on the subject of clothing, considering woolen bandages to be of great use to the legs. He had proved this in the case of horses in his own possession, the use of bandages having entirely removed windgalls as big as hens' eggs. He advocated the use of leather soles for horses working on hard roads or hard soil, or in the event of their not being used he recommended that the feet should be dressed with some soft mixture. He strongly recommended that horses, when not hard worked, should have proper exercise.

Dr. Shorthouse had been told by a stableman of large experience—Mr. Turner, of Carshalton—that the best flooring for a stable was a very inexpensive one, consisting of small chalk and ashes. He had tested this, and found it almost non-absorbent. On the other hand, he had tested one of the iron bricks used for paving in the London Road, and found to his surprise that it absorbed over 130 grains of water in 24 hours. With regard to the subject of ventilation, he held that no room could be properly ventilated without a fire. A little gas burner at the top of the room, near the ventilator, would be very serviceable in drawing out the bad air, and need not cost more than about 2*d.* per week; but, if practicable, he should prefer a fire. He quite agreed with Professor Pritchard that the stables had best be lined with wood, but he preferred pine to elm, as not being so liable to get out of shape. He thought water should be given to a horse both before and after his food, the chill being taken off it first. Water being a good absorbent, he quite agreed that it should never be allowed to stand all night in the stable. On the subject of bedding he believed heather made the best bedding known, and next came deal shavings, which he preferred to sawdust. Many horses with delicate skins suffer very much from lice. The horse Newminster used to be so tormented that he would bite pieces out of himself, but his condition was much improved when, at his (the speaker's) suggestion, he was bedded with deal shavings instead of straw. He considered cracked heels resulted chiefly from frequent washing and imperfect drying, just as a man's hair begins to turn gray over his temples first, where he washes it in washing his face, and imperfectly dries it.

A NEW UNDERGROUND MONSTER.

A RECENT communication from Fritz Müller, of Itajahy, in Southern Brazil, to the *Zoologische Garten* contains a wonderful account of the supposed existence of a gigantic earthworm in the highlands of the southern provinces of Brazil, where it is known as the "Minhocao." The stories told of this supposed animal, says Fritz Müller, sound for the most part so incredible that one is tempted to consider them as fabulous. Who could repress a smile at hearing men speak of a worm some fifty yards in length and five in breadth, covered with bones as with a coat of armor, uprooting mighty pine trees as if they were blades of grass, diverting the courses of streams into fresh channels, and turning dry land into a bottomless morass? And yet after carefully considering the different accounts given of the "Minhocao," one can hardly refuse to believe that some such animal does really exist, although not quite so large as the country folk would have us to believe.

About eight years ago a "Minhocao" appeared in the neighborhood of Lages. Francisco de Amaral Varella, when about ten kilometers distant from that town, saw lying on the bank of the Rio das Caveiras a strange animal of gigantic size, nearly one meter in thickness, not very long, and with a snout like a pig, but whether it had legs or not he could not tell. He did not dare to seize it alone, and while calling his neighbors to his assistance it vanished, not without leaving palpable marks behind it in the shape of a trench as it disappeared under the earth. A week later a similar trench, perhaps constructed by the same animal, was seen on the opposite side of Lages, about six kilometers distant from the former, and the traces were followed, which led ultimately under the roots of a large pine tree, and were lost in the marshy land. Herr F. Kelling, from whom this information was obtained, was at that time living as a merchant in Lages, and saw himself the trenches made by the "Minhocao." Herr E. Odebrecht, while surveying a line of road from Itajahy into the highlands of the province of Santa Caterina, several years ago, crossed a broad marshy plain traversed by an arm of the River Marombas. His progress here was much impeded by devious winding trenches which followed the course of the stream, and occasionally lost themselves in it. At the time Herr Odebrecht could not understand the origin of these peculiar trenches, but is now inclined to believe that they were the work of the "Minhocao."

About fourteen years ago, in the month of January, Antonio José Branco, having been absent with his whole family eight days from his house, which was situated on one of the tributaries of the Rio dos Cachorros, ten kilometers from Curitibanos, on returning home found the road undermined, heaps of earth being thrown up, and large trenches made. These trenches commenced at the source of a brook, and followed its windings, terminating ultimately in a morass after a course of from 700 to 1,000 meters. The breadth of the trenches was said to be about three meters. Since that period the brook has flowed in the trench made by the "Minhocao." The path of the animal lay generally beneath the surface of the earth under the bed of the stream; several pine trees had been rooted up by its passage. One of the trees from which the Minhocao in passing had torn off the bark and part of the wood was said to be still standing and visible last year. Hundreds of people from Curitibanos and other places had come to see the devastation caused by the Minhocao, and supposed the animal to be still living in the marshy pool, the waters of which appeared at certain times to be suddenly and strangely troubled. Indeed on still nights a rumbling sound like distant thunder and a slight movement of the earth were sensible in the neighboring dwelling. This story was told to Herr Müller by two eye witnesses, José, son of old Branco, and a step-son, who formerly lived in the same house. Herr Müller remarks that the appearance of the Minhocao is always supposed to presage a period of rainy weather.

In the neighborhood of the Rio dos Papagaios, in the province of Paraná, one evening in 1849 after a long course of rainy weather, a sound was heard in the house of a certain João de Deos, as if rain were again falling in a wood hard by, but on looking out, the heavens were seen to be bright with stars. On the following morning it was discovered that a large piece of land on the further side of a small hill had been entirely undermined, and was traversed by deep trenches which led toward a bare open plateau covered with stones, or what is called in this district a "legeado." At this spot large heaps of clay turned up out of the earth marked the onward course of the animal from the legeado into the bed of a stream running into the Papagaios. Three years after this place was visited by Senhor Lebino José dos Santos, a wealthy proprietor, now resident near Curitibanos. He saw the ground still upturned, the mounds of clay on the rocky plateau, and the remains of the moved earth in the rocky bed of the brook quite plainly, and came to the conclusion that it must have been the work of two animals, the size of which must have been from two to three meters in breadth.

In the same neighborhood, according to Senhor Lebino, a Minhocao had been seen several times before. A black woman going to draw water from a pool near a house one morning, according to her usual practice, found the whole pool destroyed, and saw a short distance off an animal which she described as being as big as a house moving off along the ground. The people whom she summoned to see the monster were too late, and found only traces of the animal, which had apparently plunged over a neighboring cliff into deep water. In the same district a young man saw a huge pine suddenly overturned, when there was no wind and no one to cut it. On hastening up to discover the cause, he found the surrounding earth in movement, and an enormous worm-like black animal in the middle of it, about twenty-five meters long, and with two horns on its head.

In the province of São Paulo, as Senhor Lebino also states, not far from Ypanema, is a spot that is still called Charquinho, that is, Little Marsh, as it formerly was, but some years ago a Minhocao made a trench through the marsh into the Ypanema River, and so converted it into the bed of a stream.

In the year 1849, Senhor Lebino was on a journey near Arapehy, in the State of Uruguay. There he was told that there was a dead Minhocao to be seen a few miles off, which had got wedged into a narrow cleft of a rock, and so perished. Its skin was said to be as thick as the bark of a pine-tree, and formed of hard scales like those of an armadillo.

From all these stories it would appear conclusive that in the high district where the Uruguay and the Paraná have their sources, excavations and long trenches are met with, which are undoubtedly the work of some living animal. Generally, if not always, they appear after continued rainy weather, and seem to start from marshes or river-beds, and to enter them again. The accounts as to the size and appearance of the creature are very uncertain. It might be suspected to be a gigantic fish allied to *Lepidosiren* and *Ceratodus*; the "swine's snout" would show some resemblance to *Ceratodus*, while the horns on the body rather point to the front limbs of *Lepidosiren*, if these particulars can be at all depended upon. In any case, concludes Herr Müller, it would be worth while to make further investigations about the Minhocao, and, if possible, to capture it for a zoological garden!

To conclude this remarkable story, we may venture to suggest whether, if any such animal really exist, which, upon the testimony produced by Fritz Müller, appears very probable, it may not rather be a relic of the race of gigantic armadillos which in past geological epochs were so abundant in Southern Brazil. The little *Chlamydophorus truncatus* is, we believe, mainly, if not entirely, subterranean in its habits. May there not still exist a larger representative of the same or nearly allied genus, or, if the suggestion be not too bold, even a last descendant of the Glyptodonts?—*Nature.*

INDIAN RELICS.

A DISCOVERY that will prove of interest to antiquaries has been made in Johnston township, Providence county, R. I. The exact locality is about one hundred yards north of the Killingly Pike, on the Big Elm Farm. Mr. H. M. Angell, of Providence, while engaged in quarrying slate at the place above indicated, found a soapstone bed between two slate ledges, about six feet underground. Cartloads of pulverized stone were removed, without any suspicion that it was the debris of an ancient mine. At last the surface of the soapstone rock was reached, and this was so curiously carved as to attract the notice of the workmen, the entire surface being covered with hollows and projections. This was a rock from which the aborigines had carved soapstone dishes and utensils. The method was to cut away the stone from a circular portion till that was left as a projection, and then cut under the projection until it was detached, after which the block thus obtained was hollowed out and became a dish or bowl. The work has been done with knives and hammers of stone, the slate furnishing a sharp edge to cut, chisel and scoop out the soapstone.

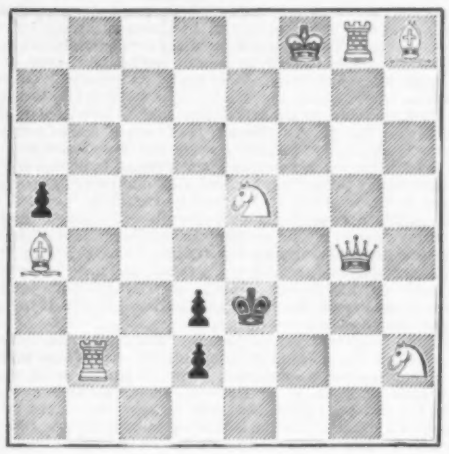
SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 78. BY GEO. E. CARPENTER.

First Prize in the Dubuque Correction Tourney, 1871.

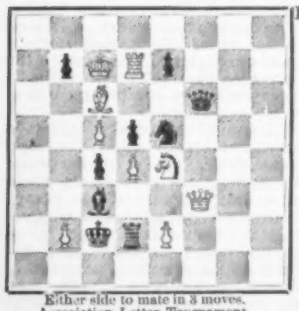
White.



Black.

White to play and mate in two moves.

JOHN COCHRANE.



Either side to mate in 3 moves.
Association Letter Tournament.

BELIEVING that a portrait of the late Mr. Cochrane would be prized by our readers, we have produced a most faithful copy of one that recently appeared in the *Westminster Papers*.

Mr. Cochrane has been before the chess world for such a long time, that but few of our players could realize that he was still living, as he had long been looked upon as one of the old masters. In a recent letter to the *Hartford Times*, Mr. I. O. Howard Taylor refers to him as one "who fifty-seven years ago encountered Deschapelles and La Bourdonnais; who had reached middle age ere Morphy, Kolisch, or Steinitz was born; whose work preceded the *Handbook* by a quarter of a century; whose fame was European thirty years before Andersen's was established." His chess work, which appeared over half a century ago, is still an authority on chess, and many of the most subtle lines of play are accredited to his research.

In the SUPPLEMENTS Nos. 118 and 121 we gave a short account of his career and a specimen of his play; we now select one of his games with La Bourdonnais, in which he plays the well-known Cochrane Gambit, and displays his peculiar brilliancy of style.

DUBUQUE PROBLEM TOURNEY NO. 2.

THIS novel tourney, known as the Correction Problem Tournament, was inaugurated in the spring of 1871, upon one of Prof. Brownson's most original plans, there being three prizes offered for the best and most artistic correction of any faulty or imperfect problem that had appeared in the *Journal*. This novel innovation met with the merited success that always crowned the efforts of our popular chess leader, and elicited quite a lively competition.

The first prize was awarded to Geo. E. Carpenter; the second to W. A. Shinkman; and the third to V. Portilla. The former we present as our regular problems, the latter as—

ENIGMA No. 46.—BY V. PORTILLA.

Third Prize in the Dubuque Correction Tourney.

White.—K on Q R 5, Q Q Kt 8, Kts Q 4 and K 6, P K R 6.
Black.—K Q B 5.
White to play and mate in three moves.

Our initial problem is one just received in competition for the Association Letter Prize, the time of entry for which, it will be remembered, is open until the announcement of the award of the Association Problem Tournament, which may require considerable time, as the competition is larger than was anticipated.

The entire collection appears in the *Chess Journal*, with the exceedingly novel idea of offering half a dozen liberal prizes to whoever can give the shrewdest guess as to who will be the prize bearers. Why do the players show so little enterprise in arranging a grand association playing tournament?

We are informed that the judges in the problem tournament will consist of Mr. Eugene B. Cook, President of the American Chess and Problem Association; Mr. Charles A. Gilberg, and Mr. Charles H. Waterbury, three of the most celebrated solvers, critics and problemists of the present day; a better selection could not possibly have been hit upon, and with such experts we can look for an early award.

SIR WALTER SCOTT gave up chess after several fruitless attempts, saying that "he could learn another language with less strain upon the mind;" but he seldom if ever returned to draughts, of which he was so fond in his younger days.

LA BOURDONNAIS AND COCHRANE.

(Cochrane Gambit.)

LA BOURDONNAIS. WHITE.	COCHRANE. BLACK.
1. P to K 4	1. P to K 4
2. P to K B 4	2. P x P
3. Kt to K B 3	3. P to K Kt 4
4. B to Q B 4	4. P to K Kt 5
5. Kt to K 5	5. Q to K R 5 ch
6. K to B sq	6. P to K B 6
7. P to K Kt 3	7. Q to K R 6 ch
8. K to B 2	8. Q to Kt 7 ch
9. K to K 3	9. B to K R 3 ch
10. K to Q 3	10. P to Q 4
11. B x P	11. Q Kt to R 3
12. P to Q B 3	12. P to Q B 3
13. B x K B P ch	13. K to K 2
14. K B to Q Kt 3	14. Q Kt to B 4 ch
15. K to B 2	15. Q Kt x K P
16. Q to K B sq	16. Q B to K B 4
17. Q x Q	17. Kt to B 7 ch
18. P to Q 3	18. P x Q
19. R to K Kt sq	19. Q R to Q sq
20. Q B x B	20. K Kt x B
21. R x P	21. K x Q P
22. Kt x Kt	22. B x Kt ch
23. K to B sq	23. K R to B sq
24. Q Kt to Q 2	24. K Kt to B 4
25. K B to Q sq	25. Kt to K 6
26. K R to Kt sq	26. B to K B 8
27. P to Q Kt 3	27. K R to B 7
28. R x B	28. Kt x R
29. Kt x Kt	29. Q R x B ch
30. K x R	30. R x Kt ch and wins.

JOHN COCHRANE.

CHESS AS A TEST OF CHARACTER.

MANY writers have described the peculiarities and eccentricities that players are apt to indulge in while absorbed in a game of chess, and some have gone so far as to claim that a fair estimation may be formed from a person's style of chess play. Be that as it may, it is a noticeable fact that no one can witness a game played by others without forming a preference and desiring the success of one over the other; and how often we are compelled to admit that our opinion regarding a person has undergone a complete change during a game of chess! Chess is a very unsociable game, yet you seem to become better acquainted and more familiar during one game than by hours or even days of conversation. A prominent physiognomist says that there is no time for studying the expression of the face as during a game of chess.

This same view has often been asserted before, and we find it cleverly expressed in *Blackwood's Magazine*, as follows:

"We know of no absorption more complete than that which possesses the mind of a true votary of chess. Watch him as he is contemplating his moves, and his countenance is a perfect study for the physiognomist. He may not, perhaps, be the most agreeable of companions, but we cannot expect loquacity from men of high intellect while engaged in deepest ruminations."

We recall a curious statement by Olaus Magnus, Archbishop of Upsal, in Sweden, who says:

"It is a custom amongst the most illustrious Goths and Swedes, when they would honestly marry their daughters, to prove the dispositions of the suitors that come to them, and to know their passions especially by playing with them at chess; for at this game their anger, love, peevishness, covetousness, dullness, idleness, and many more mad pranks, passions, and motions of their minds, and the forces and properties of their fortune, are used to be seen: as whether the wooer be rudely disposed, that he will indiscreetly rejoice, and suddenly triumph when he wins; or when he is wronged he can patiently endure it, and wisely put it off."

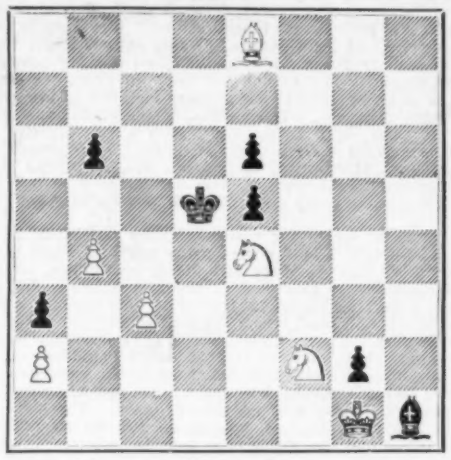
It is an ancient proverb, "Let no man play chess with his wife." And all must acknowledge its peculiar force, as we have yet to find that happy pair who will spend an evening "o'er the checkered board" without some slight misunderstanding; for as mastery at chess is considered by many to betoken superior tact and intellect, but few will acknowledge their inferiority, even when defeated.

Ferrand, Count of Flanders, used to amuse himself by playing chess with his wife, and being constantly beaten by her, a mutual hatred took place, which came to such a height that when the Count was taken prisoner at the battle of Bovines, she suffered him to remain a long time in prison, although she could easily have procured his release.

PROBLEM No. 79. BY W. A. SHINKMAN.

Second Prize in the Dubuque Correction Tourney, 1871.

White.



Black.

White to play and mate in nine moves.

SOLUTIONS TO PROBLEMS.

No. 72.—BY GEO. E. CARPENTER.

WHITE.	BLACK.
1. B to K 5	1. K to Kt 6 or B 4
2. Kt to Kt 5 ch	2. K x Kt
3. B to Q 7 ch	3. K to R 5
4. Kt to B 3 mate.	
	1. K to Q 4
2. Kt to Kt 5	2. K to B 4
3. Kt to B 6	3. K moves
4. Mates.	

No. 73.—BY G. F. BIXBY.

WHITE.	BLACK.
1. R x R ch	1. P x R
2. P x Q claiming a B	2. K to Kt 5
3. B to Q 6 mate.	

LETTER "L."—BY DR. C. C. MOORE.

WHITE.	BLACK.
1. Q x P	1. R checks
2. K x R	2. K moves
4. P queens mating.	

ENIGMA No. 39.—BY J. GARDNER.

WHITE.	BLACK.
1. R to K Kt sq	1. Any move
2. Mate follows	

ENIGMA No. 40.—BY W. A. SHINKMAN.

WHITE.	BLACK.
1. B x P	1. Any move
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ENIGMA No. 41.—BY MAX JUDD.

WHITE.	BLACK.
1. P to Q 8 Kts	1 R dis ch
2. K to R sq	2. Any move
3. Kt to K B 7 mate.	

ENIGMA NO. 42.—BY L. W. DAVIS.

WHITE.	BLACK.
1. B to R 7 ch	1. K to B 6
2. R to K Kt 5	2. P to Q 4
3 R to Kt 6	3. K to K 5
4. R to Kt 3 dis mate.	

PROBLEM SOLVING.

OWING to an absurd criticism in one of our exchanges, that seems to reflect upon Mr. Loyd's ability to solve problems, we wish to state that he makes no claim to superiority in this respect, is opposed to betting in any way, shape, or manner, and invariably contributes such prizes as fall to his lot toward creating further amusement; yet, believing that a series of solving matches would prove of interest, he is desirous of arranging a match for glory or whatever his competitors may prefer; and offers to solve two problems to one against any solver in the world, and will accept any and all propositions that can be submitted to him. Will not some of our famous analysts and critics enter the lists? The proposition excludes no one; and a few friendly matches might be arranged, it being remembered that Mr. Loyd *prefers* to have no stake at issue.

SUICIDAL PROBLEMS.

ONE of our English cotemporaries takes us severely to task for expressing our views so strongly in opposition to suicidal and conditional problems; and intimates that our views have undergone a change, as "a reference to the pages of the *American Chess Nuts* and chess organs of a later day will prove him guilty, my Lord!" thereby confessing the blotchy condition of our escutcheon.

An examination of said publications will merely show that out of upward of five hundred published problems, there are but four suicidal positions, which were composed by request to illustrate some chess sketches. We also find the following opinion, taken from a published letter "from Mr. Loyd," dated a quarter of a century ago, which proves that his views have undergone no change:

"Chess problems are positions in which mate is given, varying from two to five moves. All beyond this are merely protracted end games, more or less intricate. It has often been remarked that the fewer the moves the more beautiful the problem; and it may also be added, that the greater the number of moves, the less skill and taste in the composer.

"Suicidal and conditional monstrosities are generally the productions of plodders, more remarkable for their patience and eccentricity than taste and skill!"

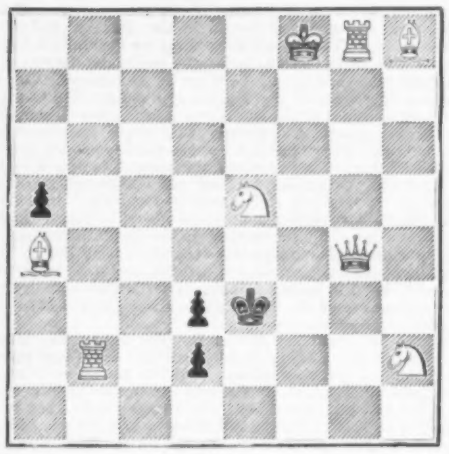
SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 78. BY GEO. E. CARPENTER.

First Prize in the Dubuque Correction Tourney, 1871.

White.



Black.

White to play and mate in two moves.

JOHN COCHRANE.

Either side to mate in 3 moves.
Association Letter Tournament.

BELIEVING that a portrait of the late Mr. Cochrane would be prized by our readers, we have produced a most faithful copy of one that recently appeared in the *Westminster Papers*.

Mr. Cochrane has been before the chess world for such a long time, that but few of our players could realize that he was still living, as he had long been looked upon as one of the old masters. In a recent letter to the *Hartford Times*, Mr. I. O. Howard Taylor refers to him as one "who fifty-seven years ago encountered Deschapelles and La Bourdonnais; who had reached middle age ere Morphy, Kolisch, or Steinitz was born; whose work preceded the *Handbook* by a quarter of a century; whose fame was European thirty years before Andersen's was established." His chess work, which appeared over half a century ago, is still an authority on chess, and many of the most subtle lines of play are accredited to his research.

In the SUPPLEMENTS Nos. 118 and 121 we gave a short account of his career and a specimen of his play; we now select one of his games with La Bourdonnais, in which he plays the well-known Cochrane Gambit, and displays his peculiar brilliancy of style.

DUBUQUE PROBLEM TOURNEY NO. 2.

THIS novel tourney, known as the Correction Problem Tournament, was inaugurated in the spring of 1871, upon one of Prof. Brownson's most original plans, there being three prizes offered for the best and most artistic correction of any faulty or imperfect problem that had appeared in the *Journal*. This novel innovation met with the merited success that always crowned the efforts of our popular chess leader, and elicited quite a lively competition.

The first prize was awarded to Geo. E. Carpenter; the second to W. A. Shinkman; and the third to V. Portilla. The former we present as our regular problems, the latter as—

ENIGMA No. 46.—BY V. PORTILLA.

Third Prize in the Dubuque Correction Tourney.

White.—K on Q R 5, Q Q Kt 3, Kts Q 4 and K 6, P K R 6.
Black.—K Q B 5.
White to play and mate in three moves.

Our initial problem is one just received in competition for the Association Letter Prize, the time of entry for which, it will be remembered, is open until the announcement of the award of the Association Problem Tournament, which may require considerable time, as the competition is larger than was anticipated.

The entire collection appears in the *Chess Journal*, with the exceedingly novel idea of offering half a dozen liberal prizes to whoever can give the shrewdest guess as to who will be the prize bearers. Why do the players show so little enterprise in arranging a grand association playing tournament?

We are informed that the judges in the problem tournament will consist of Mr. Eugene B. Cook, President of the American Chess and Problem Association; Mr. Charles A. Gilberg, and Mr. Charles H. Waterbury, three of the most celebrated solvers, critics and problemists of the present day; a better selection could not possibly have been hit upon, and with such experts we can look for an early award.

SIR WALTER SCOTT gave up chess after several fruitless attempts, saying that "he could learn another language with less strain upon the mind;" but he seldom if ever returned to draughts, of which he was so fond in his younger days.

LA BOURDONNAIS AND COCHRANE.

(Cochrane Gambit.)

LA BOURDONNAIS. WHITE.	COCHRANE. BLACK.
1. P to K 4	1. P to K 4
2. P to K B 4	2. P x P
3. Kt to K B 3	3. P to K Kt 4
4. B to Q B 4	4. P to K Kt 5
5. Kt to K 5	5. Q to K R 5 ch
6. K to B sq	6. P to K B 6
7. P to K Kt 3	7. Q to K R 6 ch
8. K to B 2	8. Q to Kt 7 ch
9. K to K 3	9. B to K R 3 ch
10. K to Q 3	10. P to Q 4
11. B x P	11. Q Kt to R 3
12. P to Q B 3	12. P to Q B 3
13. B x K B P ch	13. K to K 2
14. K B to Q Kt 3	14. Q Kt to B 4 ch
15. K to B 2	15. Q Kt x K P
16. Q to K B sq	16. Q B to K B 4
17. Q x Q	17. Kt to B 7 ch
18. P to Q 3	18. P x Q
19. R to K Kt sq	19. Q R to Q sq
20. Q B x B	20. K Kt x B
21. R x P	21. K x Q P
22. Kt x Kt	22. B x Kt ch
23. K to B sq	23. K R to B sq
24. Q Kt to Q 3	24. K Kt to B 4
25. K B to Q sq	25. Kt to K 6
26. K R to Kt sq	26. B to K B 8
27. P to Q Kt 3	27. K R to B 7
28. R x B	28. Kt x R
29. Kt x Kt	29. Q R x B ch
30. K x R	30. R x Kt ch and wins.

JOHN COCHRANE.

CHESS AS A TEST OF CHARACTER.

MANY writers have described the peculiarities and eccentricities that players are apt to indulge in while absorbed in a game of chess, and some have gone so far as to claim that a fair estimation may be formed from a person's style of chess play. Be that as it may, it is a noticeable fact that no one can witness a game played by others without forming a preference and desiring the success of one over the other; and how often we are compelled to admit that our opinion regarding a person has undergone a complete change during a game of chess! Chess is a very unsociable game, yet you seem to become better acquainted and more familiar during one game than by hours or even days of conversation. A prominent physiognomist says that there is no time for studying the expression of the face as during a game of chess.

This same view has often been asserted before, and we find it cleverly expressed in *Blackwood's Magazine*, as follows:

"We know of no absorption more complete than that which possesses the mind of a true votary of chess. Watch him as he is contemplating his moves, and his countenance is a perfect study for the physiognomist. He may not, perhaps, be the most agreeable of companions, but we cannot expect loquacity from men of high intellect while engaged in deepest ruminations."

We recall a curious statement by Olaus Magnus, Archbishop of Upsal, in Sweden, who says:

"It is a custom amongst the most illustrious Goths and Swedes, when they would honestly marry their daughters, to prove the dispositions of the suitors that come to them, and to know their passions especially by playing with them at chess; for at this game their anger, love, peevishness, covetousness, dullness, idleness, and many more mad pranks, passions, and motions of their minds, and the forces and properties of their fortune, are used to be seen: as whether the wooer be rudely disposed, that he will indiscreetly rejoice, and suddenly triumph when he wins; or when he is wronged he can patiently endure it, and wisely put it off."

It is an ancient proverb, "Let no man play chess with his wife." And all must acknowledge its peculiar force, as we have yet to find that happy pair who will spend an evening "o'er the checkered board" without some slight misunderstanding; for as mastery at chess is considered by many to betoken superior tact and intellect, but few will acknowledge their inferiority, even when defeated.

Ferrand, Count of Flanders, used to amuse himself by playing chess with his wife, and being constantly beaten by her, a mutual hatred took place, which came to such a height that when the Count was taken prisoner at the battle of Bovines, she suffered him to remain a long time in prison, although she could easily have procured his release.

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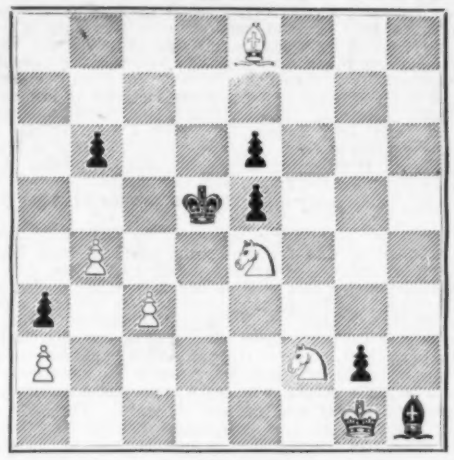

Black.

White to play and mate in nine moves.

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